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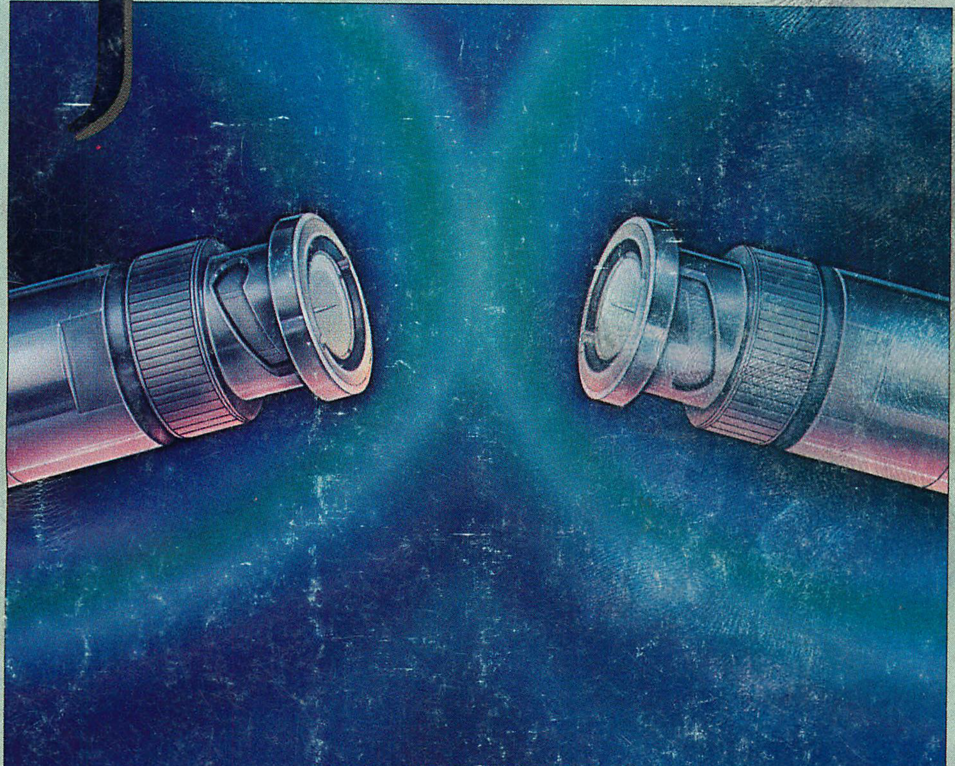
PC TECH JOURNAL



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SNA STRATEGIES

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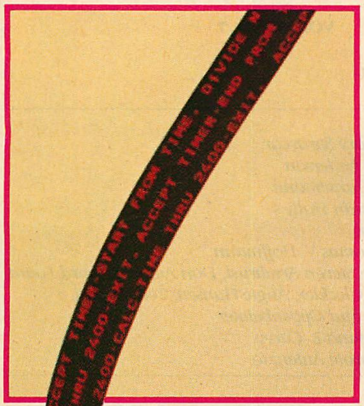
TECH PC JOURNAL

JULY 1985 VOLUME 3, NUMBER 7



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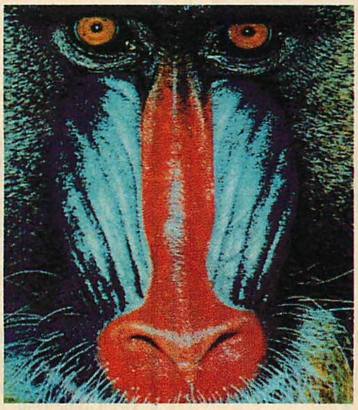

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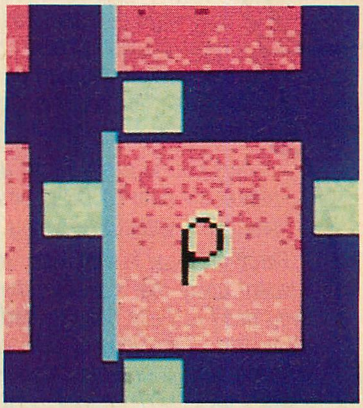

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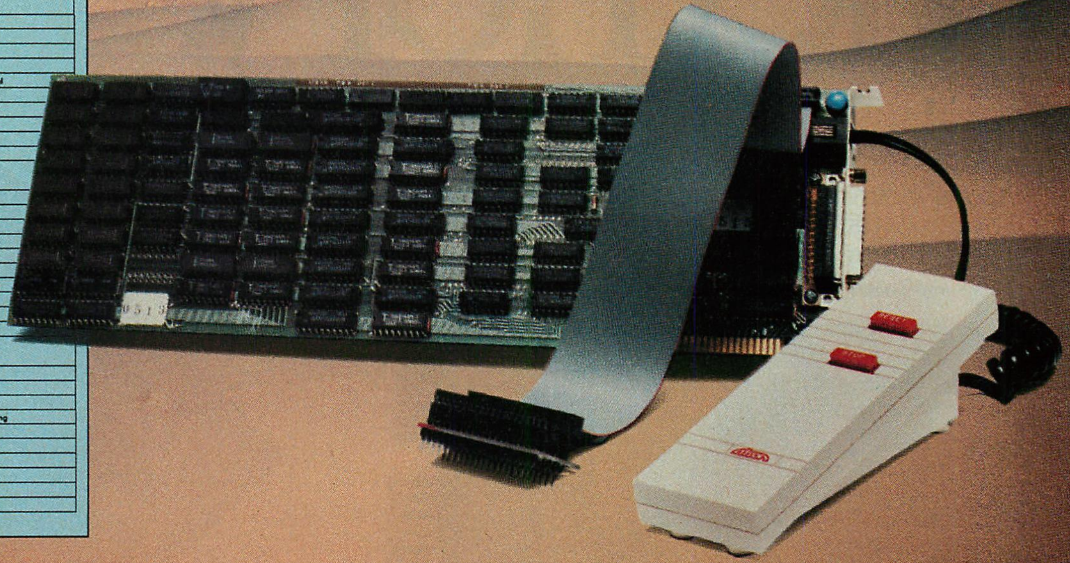
HOW DO THE TOP-RANKED SOFTWARE FIRMS MAKE THEIR BUCKETS OF SAND SO ROCK SOLID? ASK ATRON, THE PEOPLE WHO INVENTED THEIR DEBUGGING TOOLS.

PC Week/Softsel Top List—December

BUSINESS		
1	1-2-3	Lotus
2	SIDEKICK	Borland International
3	SYMPHONY	Lotus
4	DBASE III	Ashton-Tate
5	MULTIMATE	Multimate International
6	PFS:WRITE	Software Publishing
7	TAX PREPARER 1985	Howardsoft
8	PFS:FILE	Software Publishing
9	WORD PERFECT	Satellite Software
10	MICROSOFT WORD	Microsoft
HARDWARE		
1	SIXPAKPLUS	AST Research
2	HERCULES GRAPHIC CARD	Hercules
3	SMARTMODEM 1200B	Hayes
4	SMARTMODEM 1200	Hayes
5	HERCULES COLOR CARD	Hercules
6	EXPANDED QUADBOARD	Quadram
7	MASTERPIECE	Kensington Microware
8	PC MOUSE	Mouse Systems
9	MODULAR GRAPHICS CARD	Paradise Systems
10	MOUSE	Microsoft
SYSTEMS & UTILITIES		
1	PC MOUSE/PC PAINT BUNDLE	Mouse Systems
2	TURBO PASCAL	Borland International
3	CROSSTALK XVI	Microstuf
4	NORTON UTILITIES	Peter Norton Computing
5	SIDEWAYS	Funk Software
6	PROKEY	Rosesoft
7	PRINTWORKS	SoftStyle
8	SMARTCOM II	Hayes
9	TURBO TOOLBOX	Borland International
10	IN-SEARCH	Menlo Corp.



You can't pick up a PC-related magazine without seeing an editorial reference to Borland International's SIDEKICK™ program. It's one of the most popular programs ever sold to PC and PC-compatible users.

FORTUNE magazine talks about Phillip Khan's brilliantly well-executed marketing plan and a well-designed piece of software. All true. But how successful would Borland be if their product weren't absolutely rock solid?

Someone said that if your only tool is a hammer, you tend to treat all problems as if they were nails. While it's certainly possible to hammer out PC products with mere software debuggers, thousands of professionals in hundreds of companies are using Atron debugging tools.

As you can see, thirteen of the top thirty software packages were created by Atron customers. Their hammer: ATRON'S PC PROBE™, a hardware-assisted software debugging tool that plugs into your PC or compatible.

HOW THE PROS DEBUG THEIR SAND CASTLES

The PC PROBE has an umbilical that replaces your PC processor chip. Now that you can trap and catalog every signal and memory reference, you're ready to pound sand like the big boys do.

PC PROBE can trap a bug which overwrites a memory location. Because complex pointers are normally used for memory addressing, this bug occurs frequently and is quite difficult to find. As for mere software debuggers, what good is a debugger that can be wiped out by a program bug?

What better way to answer the question "How-did-I-get-here?" than to have PROBE display the real-time trace data it saved while your program was executing? Now you can do a grain-by-grain review of any sand storm.

And with the SOURCE PROBE™ upgrade to PC PROBE, you can display source-code statements* as you step through your source program. Through a window, you can continuously view critical high-level data structures. The next several source code statements are also displayed, previewing what the program is about to do.

For screen/keyboard-intensive debugging, PC PROBE's RS232 port allows screen-switching or debugging from an external CRT. For interface/hardware debugging, PC PROBE can act as a logic analyzer, trapping interrupts, I/O locations, and even signals brought in from external logic probes. All this is impossible to do with software debuggers. Which is why the pros use PC PROBE.

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*PC PROBE is compatible with Microsoft C, Lattice C, C Innovations C, Microsoft Pascal, and Assembly language. SOURCE FOR CHART: PC WEEK/SOFTSEL TOP LIST, PC WEEK, 1/29/85. Multibus™/INTEL™ Intel Corp., SIDEKICK™ Borland Interntional, PC PROBE™/MBUS PROBE™ Atron Corp. Atron also has a Multibus™ debugging product for your integrated 8086/8087/8088 applications, and the user interface is identical to PC PROBE's. Advertising by The Rick Bennett Agency, 408/258-2708.

CIRCLE NO. 203 ON READER SERVICE CARD

Graphics (Again)

IBM's standards proliferate

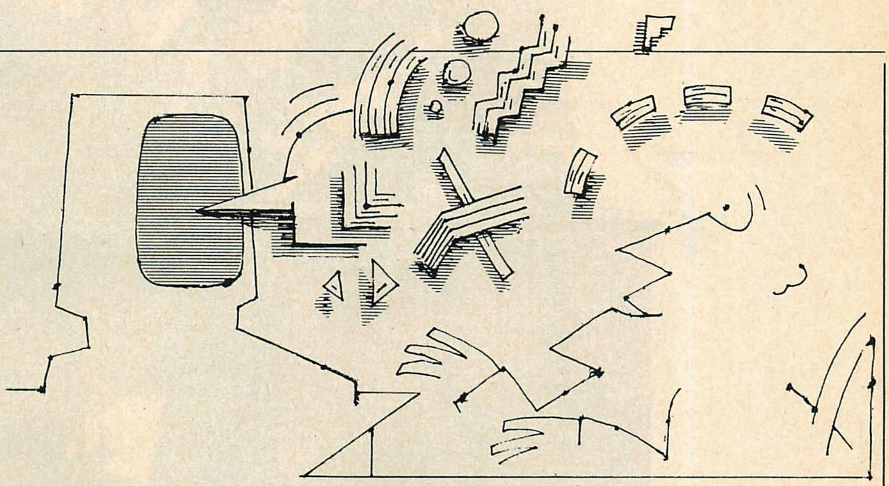

ILLUSTRATION • MACIEK ALBRECHT

The search for life at COMDEX Spring in Atlanta this year was a tough one. The most exciting new machinery turned out to be the Kaypro portable, a computer that plugs most of the holes left unfilled by the DG/One—and for $1,000 less. Some activity could be found near a number of PC/AT clones and 286-based machines. A bit of commotion was generated by accelerator cards for the PC, but some of the promised ones failed to materialize (the two reviewed in our June issue are very much alive). And if forced to select the hottest item at the show, I would point to all the new printers; a surprising number of them were introduced.

The most significant product developments of the season were not quite ready in time for the show. A number of vendors showed prototypes for graphics adapters that are compatible with IBM's Enhanced Graphics Adapter (EGA) and IBM's Professional Graphics Controller (PGC). As *PC Tech Journal* reported in April's cover story on the EGA, many vendors are working on EGA clones. So, talk of these future products was not unexpected. But, I was quite unprepared for the high level of interest in the PGC.

Perhaps I should not have been. Consulting Editor Thomas Hoffmann's review of the IBM PGC in this issue (page 56) calls out the many superb features of the device. His examination clearly shows that the Professional subsystem has potential in many graphics applications, even though it carries a high price tag and has a few failings. A less-expensive or faster clone of the PGC naturally would garner much interest. Several companies are working on such products. Orchid's TGC board even made it to COMDEX; it will boast a speed 3 to 25 times that of the PGC, depending on the operation.

Watching the evolution of graphics for the PC family is most interesting and somewhat mystifying. In the beginning, IBM provided a competitive subsystem, the Color Graphics Adapter (CGA), at a reasonable cost. It also built an excellent, high-resolution, monochrome display without graphics support. Several companies (including Orchid and Hercules) quickly capitalized on the situation by providing graphics for the IBM Monochrome Display; occasionally, Hercules even outsold IBM in graphics adapters. More recently, other companies have built similar devices that support the CGA modes on the monochrome display using 16 shades of green. This represents quite a bit of successful activity in a market IBM might have counted on dominating.

IBM listened, though. The EGA is a potent concept, providing high resolution and color, plus support for old displays and operational modes, in a single board. The PGC delivers a complete graphics processor in a compact package. Once again, IBM might be expected to corner its own market, especially with an upscale device such as the PGC. Apparently, this is not the case.

The investment required of a small, third-party company to design and build an EGA clone is enormous. Estimates begin at $500,000 and reach up to $1.5 million. Most of the money goes for the custom chips that help keep the selling price low and the size of the board within reason. Such funds may amount to chicken feed for IBM, but represent a substantial commitment for most of the companies building these products today. They are taking the dive, believing that IBM has established a new standard and that the demand for EGA-based applications will be strong. They are right, but only because these firms *are* building EGA clones. The non-IBM versions, which will have to be less expensive than IBM's model, will help the standard proliferate.

The PGC, however, is not in the same class. By all rights, it should not be a standard, because it will be sold in a more limited market segment. What third-party vendors can offer here is faster operation, more features (especially pan and zoom), and lower cost. The PGC is too expensive; others will be able to do for less than $3,000 what IBM does for $4,300. The lower price will help keep the price of a powerful graphics workstation built from an AT, for example, under $10,000. A system like that has enormous potential in small businesses needing CAD.

I always assume that IBM wants to sell hardware. However, it must want to establish standards even more. After all, every time IBM introduces a new graphics adapter, the competition takes the market away.

...IBM presents TopView.

And you can see everything through on-screen "windows" and control it all with easy-to-use pop-up menus.

You can even make unrelated programs work together; say a "Brand Y" spreadsheet with a "Brand Z" word processor.

But simplest of all is a certain "Brand IBM", namely the IBM Assistant Series—for filing, writing, planning, reporting and graphing.

Many other popular programs also work with TopView, and the number is growing.

Naturally, the more computer memory you have, the more TopView can help you. At least 512K is recommended.

And the price is only $149*.

Beyond that, all you need is to be the kind of person who never does a single thing all day, but who wants to do everything, at once.

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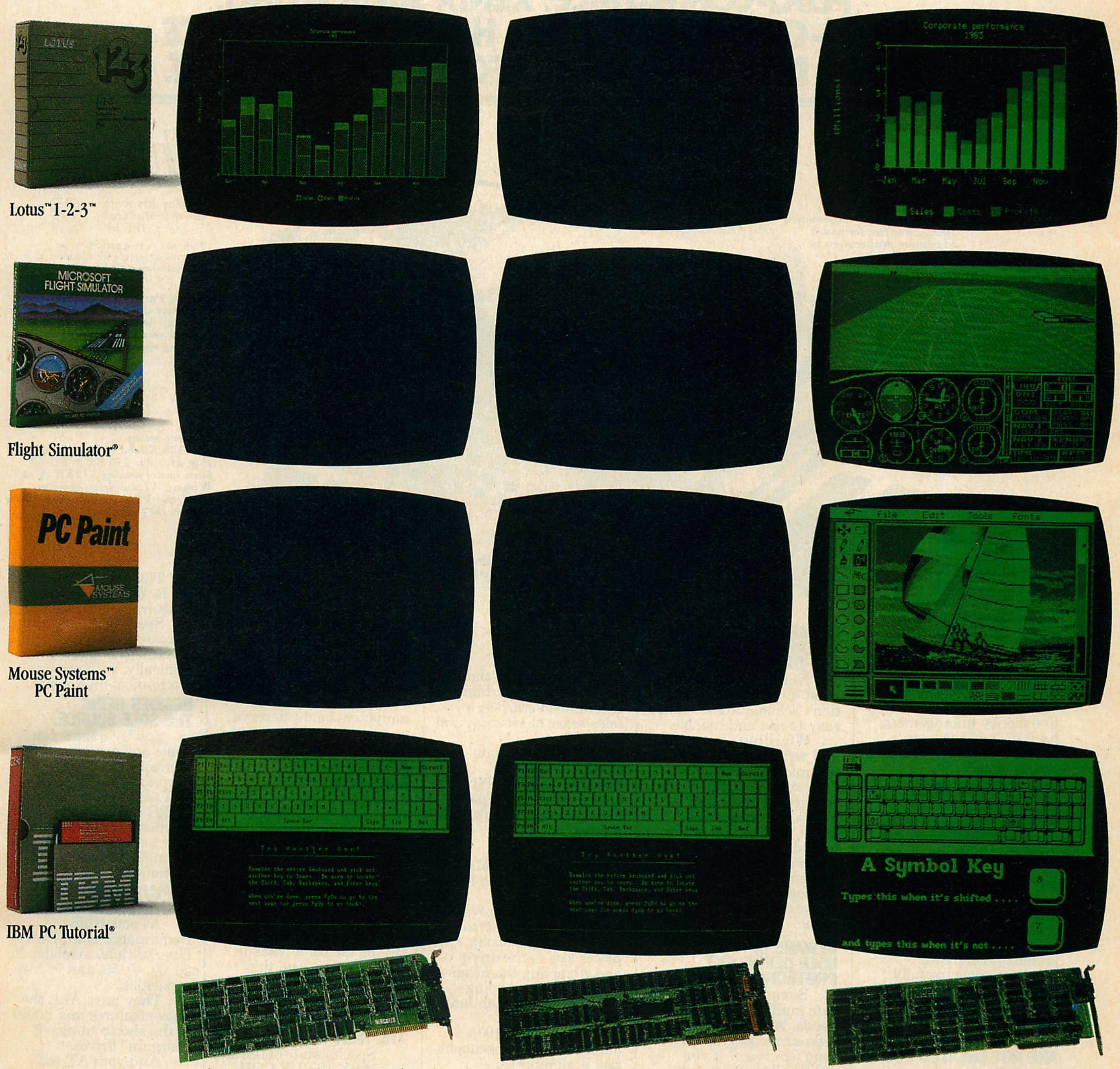

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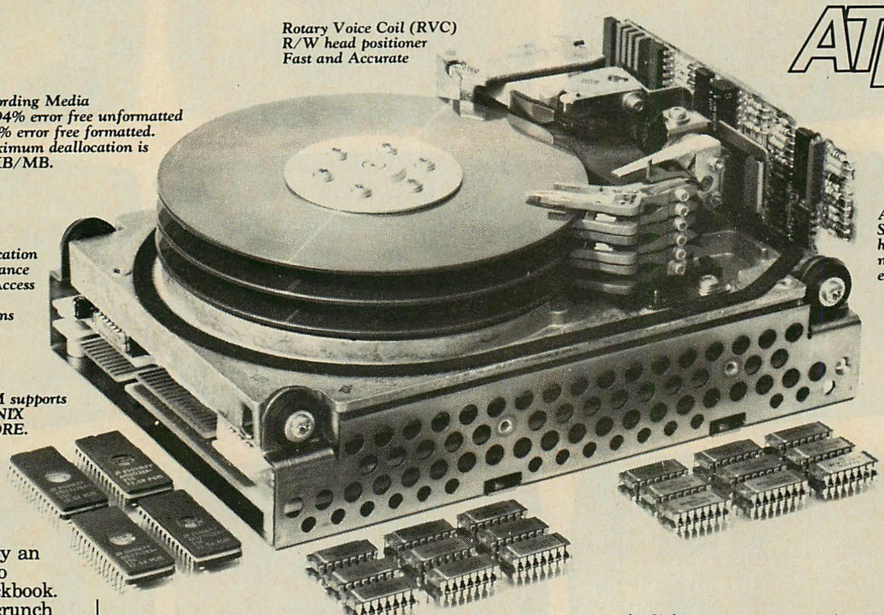
*Paradise will send you a check for $50 when you send us your old Hercules Graphics Card or IBM Monochrome Card and the Completed Paradise Modular Graphics Card Warranty. Offer Expires 8/31/85.

BEFORE YOU GET ON THE WRONG TRACK, READ THIS ABOUT THE ONLY ROM-BOOTABLE, PLUG-COMPATIBLE, XENIX SUPPORTING, HEAD-CRASH PROTECTED, HIGH-PERFORMANCE HARD DISK UPGRADE KIT FOR YOUR IBM PC-AT.



THE BALANCING ACT OF 1985.

You didn't buy an IBM PC-AT just to balance your checkbook. You bought it to crunch lots of numbers and words, in the shortest possible time. A labor saver. A time saver. Hence, a money saver.

So, do your part for effective money management; hard disk storage is no place to be penny-wise and pound foolish.

TELL 'EM YOU NEED HIGH SPEED AND DATA PROTECTION.

These and other important features do add cost, but that makes a premium drive.

Anything that can be made, can be made cheaper, sell for less, offer lower performance, and probably die young.

Remember, usually you get what you pay for, and you ALWAYS get what you don't.

ALL HARD DISKS ARE NOT CREATED EQUAL.

There are vast differences in the speed and reliability of Winchester hard disks. Since the IBM PC-AT is an incredibly fast machine, a slow drive can make an AT run like an XT.

So, before you get stuck with a slow drive in your AT, save your boss two grand and buy an XT.

Or better yet, buy the AT and avoid any drive with Access Times over 40 milliseconds.

RELIABILITY: WHERE HAS ALL THE DATA GONE?

Now tell 'em the drive must have a data protection scheme. One that's easy to use and reliable.

Winchester heads read and write while "flying" a few microns above the data surface. If the heads contact the recording media, you risk a head crash, and significant or total data loss.

So, even a fast drive without data protection is virtually worthless. Frankly, we'd rather sleep at night.

BEWARE OF USER-DEPENDENT PROTECTION SCHEMES.

Some drives have a safe landing zone for the heads, but you need to call a separate program to send 'em there. If you don't call that program, and most folks won't, the heads in these drives ALWAYS land on data when powered down.

The slightest bump or vibration can move the heads, wiping out those data tracks. And the R/W heads can become contaminated, thus increasing the error rate, slowing down average access until the whole drive fails.

Consequently, those drives offer a very high risk of head crashes, a false sense of security, and little else.

What's your data worth? $200? $400? Specify AUTOMATIC data protection. ATplus has it. And it doesn't cost, it pays.

PEACE OF MIND.

Specify AUTOMATIC park and lock of the heads on power down.

This system provides unparalleled head crash protection, by sensing power loss to the drive, and retracting the heads to a dedicated landing zone before they can land on your data.

Since this is 100% automatic, user-dependent risk is eliminated.

OUR DRIVES HAVE ALL BEEN TO BOOT CAMP.

Avoid drives that CLAIM PC-AT compatibility but can't BOOT the AT. By the time you juggle the diskettes necessary to use one of those drives, the phrase "user-hostile" will have deep personal significance.

We believe that computers ought to serve people, not the other way around.

BEWARE OF THE BARGAIN BAND-SCHLEPPER.

Avoid drives with inexpensive Band-Stepper positioner technology. These were pretty good way back in 1980, considering that's all anyone had. But by today's standards, they're inaccurate and very mechanical.

They waste time looking for the right track to read or write. And they're worth no where near the price you'll pay for 'em –in more ways than one.

THE HIGH TECH SOLUTION.

Specify state-of-the-art ROTARY VOICE COIL (RVC) head positioner and CLOSED LOOP SERVO technologies.

This system uses a DEDICATED SERVO SURFACE (DSS) for continuous head location information.

The RVC and DSS use a large scale microprocessor to translate new track-seek commands into current that is applied directly to the RVC.

This moves and holds the R/W heads at the exact track intended.

Speed is dramatically increased since head movement is created electronically, with minimal mechanical interfacing.

BESIDES BEING THE SOLE SOURCE.

Specify names you know and can trust. Like Control Data Corporation, a world leader in hard disk technology. And CORE INTERNATIONAL, a growth company with over ten years in computer technology, design and manufacturing.

ATPLUS: IDEAL FOR THE SPECS MANIAC.

ATplus High Performance Hard Disk Upgrade kits, available in 20, 30, 40, 56, and 72 MB capacities.

They have ALL the above features and none of the shortcomings of "bargain" drives.

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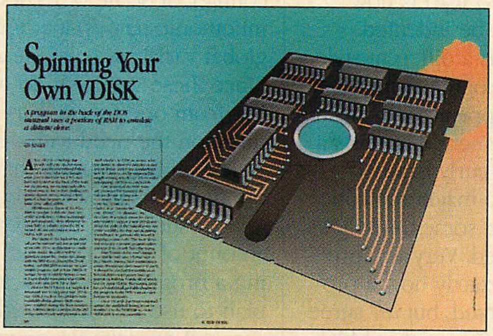

BBS AND COMZAP COMMENTS

Do it! Do it! Just based on the quality of your articles, a *PC Tech Journal* BBS would probably be the most popular BBS within a couple of weeks. Even with off-hours of 6 p.m. to 6 a.m. EST it would be a very busy BBS. A toll-free 800 number would be a great idea. You could even get in a few advertisements between the downloaded files.

While I'm at it, let me ask a question about the article, "Spinning Your Own VDISK" (Ed Nisley, March 1985, p. 100). At the end Nisley mentioned his CAUTO.BAT file. In the batch file there is mention of COMZAP.COM, which appears to be a utility for the DOS 2.0 "SET COMSPEC=" bug. If this is so, how may I get a copy of this utility?

Bruce Foat
Solano Beach, CA

Is it possible to obtain the patch to the bug in the COMSPEC routine in DOS 2.1 that is included in the CAUTO.BAT file listings in the article, "Spinning Your Own VDISK"?

Richard Sherrington
Port Hood
Cape Breton Island
Nova Scotia, Canada

We have received several requests for the COMZAP program. It is included on page 149 in this issue.

On the subject of the BBS, reader response has been overwhelmingly positive. The PC Tech Journal *BBS should be on-line this month.*

—WF

NO FASTER RAM

I noticed two apparent errors in the March 1985 issue of *PC Tech Journal*. In the JRAM-2 review ("Enhancement by JRAM-2," Don Awalt, March 1985, p. 92), it is stated that faster RAM chips would speed up the RAM disk. As I understand it, this is not true because the CPU always allows the same amount of time for memory access regardless of the chips used and has no way of knowing the speed of the memory. If the memory is not fast enough then errors occur; there is no waiting.

The article, "Spinning Your Own VDISK" (Ed Nisley, March 1985, p. 100), stated that the manual for DOS 2.0 (or later) contains the source listing of VDISK. This is true only for DOS 2.0. Users of DOS 2.1 must buy the DOS *Technical Reference Manual.* I believe that DOS 3.0 contains the program on disk, but the source is in the DOS 3.0 *Technical Reference Manual.*

David Gaudine
Montreal, Canada

Mr. Gaudine is correct. The IBM PC requires a maximum memory access time of two CPU cycles (420 ns) minus electronic signal propagation time through memory access circuitry. Tall Tree Systems states that memory access time must be 250 ns (the PC is supplied with 200-ns chips), implying a safe 170-ns estimate of propagation delay. There is no performance advantage to faster memory, yet insufficient speed will cause memory parity errors on the PC.

Computer manufacturers usually design systems with memory access speed approximating one CPU cycle (210 ns); in addition to propagation delay, RAM chips exceed their maximum access time in certain situations. Two TTL-level clocks, Row-Address Strobe (RAS), and Column-Address Strobe (CAS) form a 64KB memory address by latching separate eight-bit values. The number and design of chips used in memory circuitry can result in a delay of 35 ns to well over 100 ns between activation of RAS and CAS. If 250-ns RAM chips are used, a latency between RAS and CAS in excess of 100 ns results in memory access time in excess of 250 ns.

Faster chips are still the recommended purchase. The JRAM user's manual states faster memory is less prone to failure when first used, yet Tall Tree believes the expense of faster chips is not justified by the difference in failure rate. However, 150-ns memory chips are now much less expensive than 200- or 250-ns chips; single quantity prices from electronics distributors fall in the $1.45 to $1.70 range. Faster chips may be used for memory expansion in future, faster computers.

—Don Awalt

The source listing for the installable virtual disk driver to which Ed Nisley referred is printed on pages 14-27 to 14-34 in the DOS 2.0 manual and on pages 3-27 to 3-34 in the DOS 2.1 Technical Reference Manual. *A different virtual device driver, which can be customized through parameters specified in the CONFIG.SYS command line, is supplied with DOS 3.0. This driver, VDISK.SYS is included on the DOS 3.0 disk, and the source listing, VDISK.LST, is on the DOS 3.0 supplemental disk.*

—JA

A REQUEST FOR READABLE CODE

I am now in the process of typing in the **btsys** program, as printed in the March 1985 issue of *PC Tech Journal* ("Tree Structures," Atindra Chaturvedi, p. 131). I was impressed with the clarity of the writing style in the article, but I have some reservations about the program code as printed in the magazine.

I had some problems reading Mr. Charturvedi's source code. They were mainly caused by problems with the indentation of the code, but were aggravated by some of the variable names Mr. Chaturvedi used. As an experienced, professional programmer, I look to the indentation of a program for clues as to how the program is organized. It helps me keep my place while reading and imposes a structure on the program that is essential to understanding.

One of the most virulent arguments in the computer industry (second

only to which editor to use) is how program code should be indented. Every programmer has a different style. For example, some programmers think curly braces should appear on the same line as the while statement that starts a loop. Some think the curly brace should be indented to match the code of the while loop, and some think it should not be indented. Very few programmers agree on exactly how a program should be indented, but *all* agree that the indentation scheme should be consistent throughout.

In the **btsys** listing I was unable to discern a consistent indentation scheme. Often the code for a loop would not be indented at all, indentation levels changed from page to page, and lines often started at random levels of indentation. My guess is this was not caused by the author, but instead happened while the article was being typeset.

Since all programs you publish are written for, and run on, IBM PCs (or compatibles) you should be able to ask writers to provide machine readable copies of their source code. Given this, you should be able to impose a consistent (across articles) scheme for indentation. (Several C beautifiers, or programs that massage source code into beautiful form, are available.) This would radically improve readability of programs. Another suggestion would be to publish a set of code standards that all contributors would be required to adhere to. In my group, we adhere rather rigidly to a fairly strict standard. This is done by mutual consent, rather than by fiat from a manager.

On another issue, Mr. Chaturvedi often uses the variable *i* to store the return value from functions that return an error code. He then uses this value to set an error code. I would prefer to see a more mnemonic variable name chosen—for example, *errcode* or *retval.* Now that we are no longer restricted to single character variable names by primitive compilers, we should write programs that are easier to read, rather than easier to type.

I have the same problem with Mr. Chaturvedi's use of the variables *ip1, ip2, ip3, cp1, cp2,* and *cp3*. These names do not describe what values are stored in them, beyond the basic syntactic information that they contain pointers to integers or characters. Their presence as global variables also makes debugging more difficult.

While it is not incredibly important that variables used very locally, as in the error code case above, or as a loop counter or some other local use have mnemonic names, it is important that global variables have meaningful names. Since these variables do not carry values from one function to another, I question the need to have them declared globally, rather than locally in the functions in which they are used.

In summary, I appreciate the amount of work that goes in to preparing a program for publication, and I plan to use Mr. Chaturvedi's program in some of my own programs, but I would hope that more attention will be paid to the typeset appearance of the source code of programs in the future.

Ross Hunter
Seattle, WA

Mr. Hunter's comments are legitimate. Using consistent indentation, meaningful variable names, and local variables not only makes a program more readable but easier to maintain and debug. Unfortunately, space constraints force us to compromise our strong beliefs in creating beautiful programs. Sometimes we need to delete white space to shorten the length of a program, and we must trade off consistent indentation in order to compress each listing line into the maximum width of 65 characters.

—JA

ANOTHER CRC ROUTINE

W. David Schwaderer's article on "CRC Calculation" (April 1985, p. 118) attracted my attention because I have also faced this problem. The IBM Synchronous Communications Adapter uses the Intel 8251 USART, which has no CRC calculation hardware. My CRC routine is written in 8088 assembly language, but the algorithm could be adapted. The advantage of my algorithm is that no table of intermediate values is required.

In searching for a per-byte CRC calculation algorithm I drew a table (at right) similar to that in figure 10 of the article. This table has been reduced by removing duplicate values (the exclusive OR of any number and itself is 0). It is useful to put a couple of the duplicates back into the table. Doing this and slightly rearranging the order of the values produces the accompanying table. Note that the 15th column from the right has two C8s and two D8s. Note also that columns 1, 15, and 16 contain all the bits of the data byte and all the bits of the low-order CRC byte. What results if you exclusive OR all of the bits of a byte. It's parity.

Aha! Our calculation now becomes simple. Let CH be the high byte of the

CRC TABLE

0	0	0	0	0	0	0	0	C16	C15	C14	C13	C12	C11	C10	C9
	D8	D7	D6	D5	D4	D3	D2	D1							
	C8	C7	C6	C5	C4	C3	C2	C1							
		D8	D7	D6	D5	D4	D3	D2	D1						
		C8	C7	C6	C5	C4	C3	C2	C1						
D1	D1														D1
D2	D2														D2
D3	D3														D3
D4	D4														D4
D5	D5														D5
D6	D6														D6
D7	D7														D7
D8	D8														D8
C1	C1														C1
C2	C2														C2
C3	C3														C3
C4	C4														C4
C5	C5														C5
C6	C6														C6
C7	C7														C7
C8	C8														C8

This table has been reduced by removing duplicate values. The fifteenth column from the right has two D8s and two C8s.

CRC LISTING

```
;start of listing

;ROUTINE:  CRC-16

;This assembly language routine calculates
;the CRC-16 a byte at a time. At entry,
;the current CRC-16 accumulation should
;be in BX register and the new byte in the
;AL register. Upon exit, the new CRC-16
;accumulation is left in the BX register.
;CL is destroyed.

;Written by:  George Dinwiddie
;date:        10 July 1984

crc16proc       proc    near

crc16:  xor     ax,bx           ;AL contains (X7-0 xor Y7-0)
        xor     ah,ah           ;clear AH
        mov     cl,8
        shr     bx,cl           ;BL contains (X15-8), clear BH
        or      ax,ax           ;set parity flag
        jpe     crc16x          ;if (X7-0 xor Y7-0) has odd parity
        xor     bx,0c001h       ;then adjust crc bits 15, 14, and 0
crc16x: mov     cl,6
        rol     ax,cl
        xor     bx,ax
        rol     ax,1
        xor     bx,ax           ;bx has new crc-16 accumulation
        ret
crc16proc       endp

;end of listing
```

CRC accumulation (C-16-C9) and CL be the low byte (C8-C1) and D be the data byte. We exclusive OR CH and (CL*64) and (D*64) and (CL*128) and (D*128). Save this result. Then, if the parity of CL exclusive ORed with D is odd, we exclusive OR the above result with C001H.

The listing (at right) shows this in assembly code. Note that the comments refer to X15-0 instead of C16-1 and Y7-0 instead of D8-1. To calculate the CRC during transmission: (1) clear the CRC word (the BX register), (2) calculate the CRC word for each data byte (the AL register), and (3) transmit the CRC word low byte first.

On the receiving end, (1) clear the CRC word (the BX register), (2) calculate the CRC word for each data byte and the received CRC bytes, and (3) compare the calculated CRC with 0.

On an unrelated subject, please install a BBS to allow downloading listings and uploading letters and comments. Many magazines have done so. They may be hard to reach sometimes because of the volume of use, but it's better than rekeying everything. The fact that they are so hard to reach is an indication of their popularity.

George Dinwiddie
Columbia, MD

Your assembly language CRC calculator, while crisp and elegant, carries considerable overhead in bit manipulation. While acceptably fast when implemented in assembly language, the algorithm would become intolerably slow if implemented in a high-level language. The purpose of the 512-byte intermediate value table is to avoid calculation and bit manipulation as much as possible. Five-hundred-twelve bytes is a small penalty to pay to be able to implement CRC in a high-level language.

As for a BBS, ours is in the works, and with luck it will be available for use by the time you read this.

—WF

SEARCHING FOR SHORTCUTS

In the article, "Searching with Soundex" (Thomas W. Madron, April 1985, p. 163), the author presents a needlessly complex BASIC function for ensuring that a character is in the uppercase, and he uses four column inches discussing it. He correctly observes that ASCII codes for the uppercase characters are 32 lower that those for the lowercase characters. What he apparently did not realize is that this means that the 32 bit is "on" in the lowercase characters and "off" in the uppercase. Thus, there is a simple way of ensuring uppercase—just turn off the 32 bit:

```
A$ = CHR$(ASC(A$) and 223)
```

Since 223 is 255 − 32, ANDing the ASCII value of a character with 223 has the effect of preserving all bits except the 32 bit, which it turns off. Isn't it easy at times to see shortcuts in other people's programming.

Although this article and program seem a little trivial for *PC Tech Journal*, it's nice to see a language other than Assembly language in your pages.

Fred A. Kanel
Strongsville, OH

The focus of Mr. Kanel's letter is in the following function:

```
250 DEF FNUL$(C$)=CHR$(ASC(C$)+
   32*(95(ASC(C$)))
```

An alternative method would be simply to reset bit 5 (numbering from right to left beginning with 0) using a bit resetting function such as the following,

where A$ contains the target letter, and N$ is the bit to be reset (5):

```
10 DEF FNRB$(A$,N%)=CHR$(ASC(A$)
   AND NOT 2^N%)
```

Or, like the other approaches, Mr. Kanel's can be turned into a function:

```
10 DEF FNUC$(A$)=CHR$(ASC(A$) AND
   223)
```

And, with a little thought, we could come up with other ways to handle lower- to uppercase conversion.

Finally, the point of the article was not the minor issue of lower- to uppercase conversions, but to explain the Soundex algorithm and its actual and potential uses—a nontrivial objective. The art of programming is, to a large extent, less a matter of science than one of style and taste.

—Thomas Madron

2400 COMPLAINTS

I just read your review of the Courier 2400 (Product of the Month, May 1985, p. 25) in which you state, ". . . only U.S. Robotics is actually delivering such a product." I find this somewhat surprising since I have been using a Concord 2400-baud asynchronous modem for more than a year now. I wonder about the other "announced but not delivered" modems. Did you call all 10 manufacturers (in your article you say *at least* 10 manufacturers have announced 2400 baud modems)? Can you even list which 10 manufacturers have announced? Or did you merely pull the number 10 out of a hat?

Also, I think Tymnet supports the 2400-baud modems. Does this mean that information services accessible through Tymnet can use them? Did your author research this?

This is far from the first error I have found in your magazine. I think we have a right to expect better quality from a magazine that, by title claims to be both technical and a journal.

Barry Margolius
New York, NY

Certainly many modems have been on the market for some time that operate at speeds greater than 1200 baud (up to 9600, in fact). But most of these products are considered outside the desktop market by virtue of high price or lack of Hayes compatibility. The Concord fails the second test. And, yes, we had 10 firm "yes" answers (no hat was used) to our queries about delivery; only three showed up, and only one, the USR Courier, was Hayes-compatible.

The availability of 2400-baud service from a communications supplier (such as Tymnet or Telenet) does not imply that the information service (such as The Source or CompuServe) can support such speed. We did not check all the services, but the ones we use most frequently (The Source, Dow Jones, MCIMail, OAG) do not yet support 2400-baud service.

Since we chose the Courier 2400 as Product of the Month, other modems have been delivered. Our selection of U.S. Robotics stands, if for no other reason than its aggressive price.

—WF

ERRATA

Photographer John Lei should be credited for his work in "Graphic Enhancement" (April 1985, p. 58). In the May 1985 issue, credit should be given to George Kelvin for his illustration in "Bubble Boards" (p. 123). Also in the May issue, illustrator Tom Curry's name was misspelled (p. 199).

Not long ago, *PC* Magazine called MDBS III "The most complete and flexible data base management system available for microcomputers." That's a powerful statement. But then, MDBS III is an amazingly powerful software package. So powerful, in fact, that it lets you build mainframe-quality application systems on your micro or mini. MDBS III is not for beginners. It's for application developers with large data bases or complex data interrelationships who want to define data base structures in the most natural way—without resorting to redundancy or artificial constructs. It's for professionals who can appreciate its extensive data security and integrity features, transaction logging, ad hoc query and report writing capability and its ability to serve multiple simultaneous users. And if you want the power and the glory that only the world's most advanced data management system can provide, MDBS III is for you. For information on MDBS III and our professional consulting services, write or call Micro Data Base Systems, Inc., MDBS/Application Development Products, 85 West Algonquin Road, Suite 400, Arlington Heights, IL 60005. (800) 323-3629, or (312) 981-9200. **MDBS III. ABSOLUTE POWER.**

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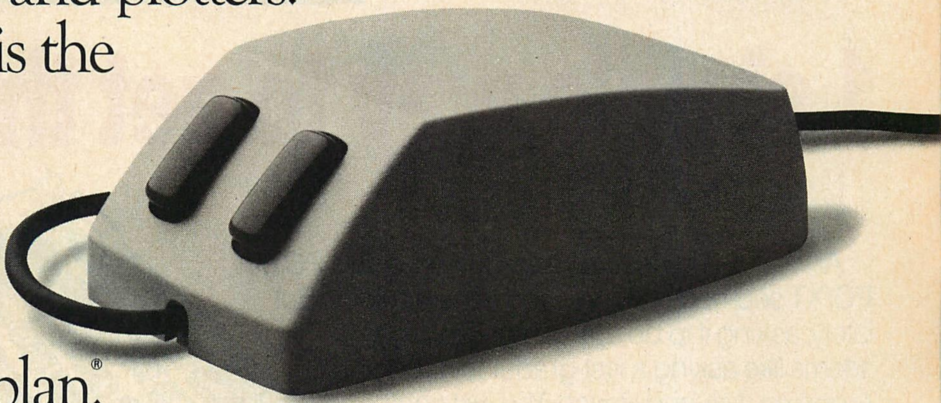

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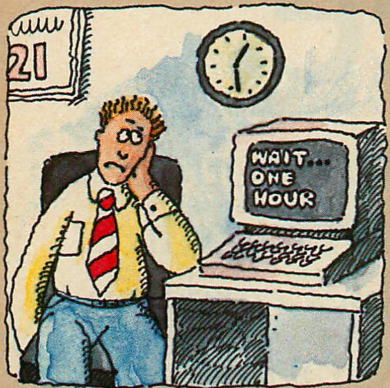

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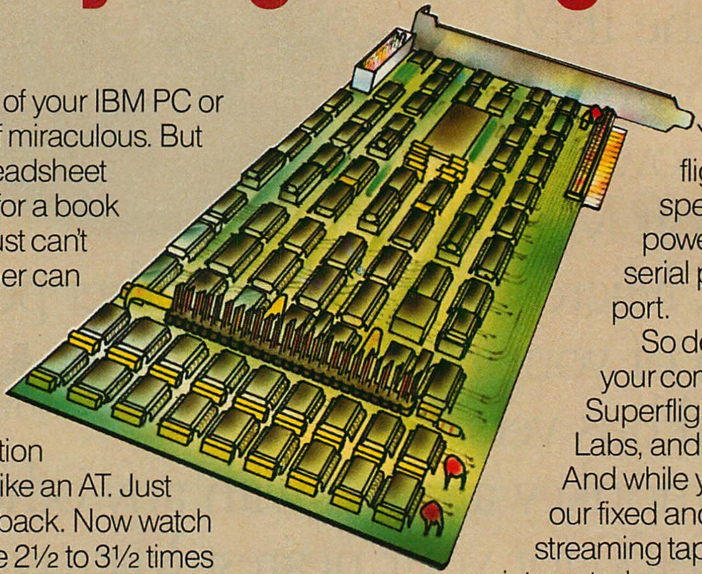

At first, the processing speed of your IBM PC or PC/XT seemed nothing short of miraculous. But lately, asking it to do a large spreadsheet seems like asking a first-grader for a book report on War and Peace. You just can't afford to wait that long. But neither can you afford to buy a new PC/AT.

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Kamerman Labs

8054 S.W. Nimbus Ave., Beaverton, OR 97005
Telex 501 886

MetaWINDOW

This graphics library offers a solution to the problem of adapting to different hardware.

Standards, like the soft hollows caused by years of traffic on stone steps, cannot be made suddenly: they develop over time as many feet walk the same path. If that path is not wide enough for all traffic, however, other paths appear and no single path is *the* path to use.

So it is with IBM PC graphics. While many graphics boards have come onto the scene, no single board is both good enough and widely used enough to be considered a standard. This has put a special strain on graphics software, but Metagraphics' MetaWINDOW seems to have found an answer.

Because the PC is not fast enough to support the overhead of a graphics VDI (virtual device interface), good graphics applications must write directly to the video buffer—and each graphics board has its own way of mapping the video buffer. The burden has always fallen upon the sellers of graphics tools to support new graphics boards as they have appeared. This process ensures that only best-selling boards will be supported, and then only after a board has been on the market a long time.

Someone had a better idea: a graphics library that can be installed for arbitrary graphics hardware without reassembling the source. For that better idea, *PC Tech Journal* congratulates Metagraphics' MetaWINDOW graphics library as its July Product of the Month.

MetaWINDOW is a general-purpose graphics utility library that includes prewritten support for most major graphics cards, including the IBM CGA and EGA, AST MonoGraphPlus, Tecmar Graphics Master, Hercules, CCS SuperVision, and STB GraphicsPlus II. It can be called from IBM/Microsoft Pascal and C, IBM FORTRAN, IBM Compiled BASIC, IBM/Microsoft Macroassembler, CI-C86, Lattice C, and Turbo Pascal. Supported mice include the Microsoft Mouse and Mouse Systems PC Mouse.

MetaWINDOW provides viewports and pop-up windows with clipping and coordinate transformation; other routines draw points, lines, rectangles, rectangles with rounded corners, polygons, arcs and wedges, and generalized ellipses, including circles. BITBLT or "rasterop" functions (corresponding to GET and PUT in BASICA) are also supported, including a ZOOMBITS function for scaling bitmaps up or down.

Other functions include the ability to determine from within the program the kind of graphics hardware that is installed in the system, interrupt-driven mouse cursor tracking, and the ability to determine whether a given point is part of a line, arc, ellipse, or polygon.

PRODUCT NAME
MetaWINDOW

COMPANY
Metagraphics Software Corporation

ADDRESS
444 Castro Street, Suite 400
Mountain View, CA 94041

TELEPHONE
415/964-1334
408/338-2992 (bulletin board)

PRICE
$150.00 (linkable library version)
$49.50 (Turbo Pascal version)

Most of these features can be had in other graphics libraries. Unique to MetaWINDOW, however, is a program-accessible structure that defines the size, shape, and location of the graphics buffer memory map. This structure includes an array of pointers to the first byte of every displayed scanline on the video raster, so applications code does not have to deal with interleaving and other bitmap peculiarities at all. A single compiled graphics application can be installed for nearly any bitmapped graphics board by loading this structure from a disk file, making hardware-specific overlays or multiple copies of the program unnecessary.

To test this feature, MetaWINDOW was installed on the MDS Genius VHR 401 bitmapped display (738 by 1004), which the personnel at Metagraphics had never seen; it worked beautifully. No other graphics library known to *PC Tech Journal* can be installed without recompiling or assembling source code on any graphics system that is unknown to its vendors.

It gets better. MetaWINDOW for Turbo Pascal is $49.95. This out-Borlands Borland's own Turbo Graphics Toolbox, which costs $54.95 and supports only the IBM CGA, Zenith Z100, and Hercules graphics boards. (The regular linkable library version costs $150.00.)

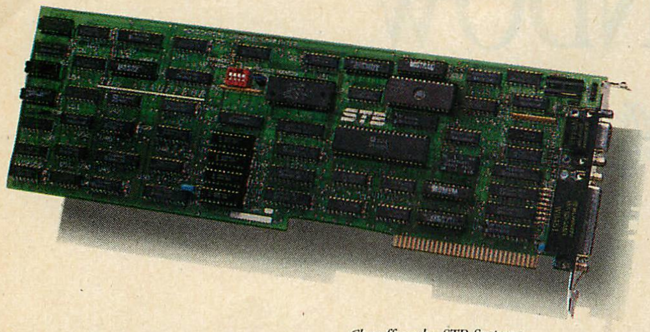
Some minor limitations may inhibit MetaWINDOW's installability: A bitmap may devote no more than eight bits to a pixel. In addition, multiplane bitmaps and "smart" graphics systems, such as IBM's Professional Graphics Controller, cannot be installed.

Informal timings of various MetaWINDOW routines show that it is at least as fast as Halo and considerably faster than the Turbo Graphics Toolbox. MetaWINDOW's documentation is typeset, illustrated, and easy to follow.

The Turbo Pascal version of MetaWINDOW is an exit-remain resident DOS extension. Metagraphics allows program developers to distribute the DOS extension with their graphics products without license fees as long as the Metagraphics copyright notice appears on the diskette. (Distributing products generated with the linked library version does require licensing.)

MetaWINDOW solves many problems that bedevil graphics software developers: nonstandard hardware, high library cost, poor documentation, license fees, and confining license agreements. For proprietary graphics, this product may be the only choice.

Hardware, software, and other developments for the PC



Chauffeur by STB Systems

PC/XT

HARDWARE

IBM Corporation has introduced two new versions of the **PC/XT** and has announced price changes on selected PCs and options (table at right). One new XT comes with 256KB of user memory and a single 360KB diskette drive; this configuration may be upgraded by adding a second 360KB diskette drive or a 10MB fixed-disk drive. The other new XT comes with 256KB of user memory and two 360KB diskette drives; a 10MB fixed-disk drive may be substituted for the second diskette drive. Both new versions use the XT planar board, which includes the 16-bit Intel 8088 microprocessor, the XT power supply, and eight expansion slots. *IBM Corporation, Entry Systems Division, P. O. Box 1328, Boca Raton, FL 33432 (Contact the local IBM dealer.)*
CIRCLE 306 ON READER SERVICE CARD

IBM Corporation also has announced the new **Model 011** of its **5531 Industrial Computer**, and the **7534 Industrial Graphics Display**. Both offer extended operation in the areas of temperature, humidity, vibration and shock, power-line transients, and particulate filtering. Model 011 can be fully configured to match the capabilities of the existing 5531. The new system offers a cooling fan for the power supply and the system unit components, an industrialized keyboard, industrially hardened covers, and a cover door over the diskette area. Model 011, $3,810.

The new 7534 Industrial Graphics Adapter, when combined with the IBM Enhanced Graphics Adapter, provides 640-by-350 picture element definition and can use 16 colors at a time from a palette of 64. The display has a protective clear screen cover and includes a dual-frequency design that permits 22 kHz for enhanced operations 15.75 kHz for compatibility modes. $1,175.

TABLE 1: *IBM Pricing*

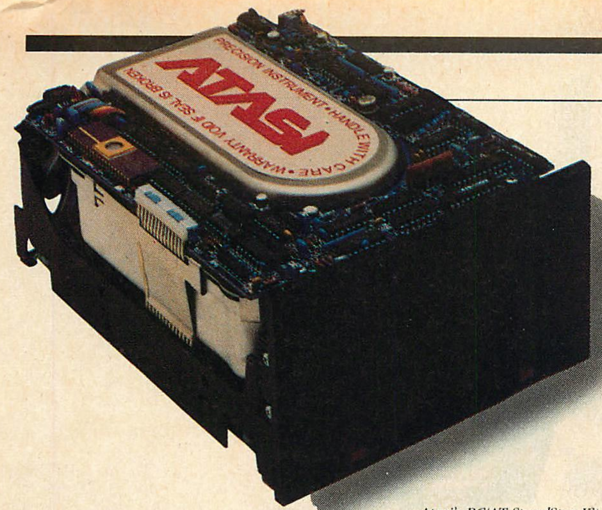
NEW IBM PC/XT VERSIONS	PRICE	
PC/XT 256KB/360KB diskette drive	$2,270	
PC/XT 256KB/2-360KB diskette drives	2,570	
IBM SYSTEM UNITS (with keyboard)	**NEW PRICE**	**FORMER PRICE**
PC 64KB	$1,390	$1,265
PC 64KB/2-360KB diskette drives	2,115	2,240
PC 256KB/2-360KB diskette drives	2,295	2,420
PC/XT 128KB/360KB diskette drive, 10MB fixed-disk drive, Asynchronous Communications Adapter	3,775	4,275
PC/XT 256KB/360KB diskette drive, 10MB fixed-disk drive, Asynchronous Communications Adapter	3,895	4,395
Portable PC 256KB/2-360KB diskette drives	2,895	3,020
IBM HARDWARE OPTIONS		
10MB fixed-disk drive	1,195	1,395
Fixed-disk adapter	495	590
PC expansion unit	2,585	2,880
PC/XT expansion unit	2,090	2,290
RELATED IBM PC PRODUCTS[1]		
3270-PC model 002	3,745	3,785
3270-PC model 004	4,485	4,650
3270-PC model 006	5,710	6,210
3270-PC model 024	5,825	5,990
3270-PC model 026	7,050	7,550
3270-PC G/GX model 012	4,090	4,130
3270-PC G/GX model 014	4,590	4,755
3270-PC G/GX model 016	6,080	6,580
PC/XT-370	7,895	8,395

[1]Available through IBM's National Accounts and National Marketing divisions.

Several price reductions on other products were announced with the new PC/XTs.

IBM Corporation, Manufacturing Systems Products, P.O. Box 1328, Boca Raton, FL 33432
CIRCLE 307 ON READER SERVICE CARD

In addition, a new model of the IBM System 9000—the **9003 industrial computer**, designed to handle a wide variety of manufacturing and process control tasks, has been announced by **IBM**. The IBM 9003 can operate on a plant floor or in other industrial environments as a stand-alone computer or as part of an IBM host computer network via optional Systems Network Architecture features. The unit is in a sealed cabinet to protect against contaminants such as oil mist, dust, other particulates, and water. The 9003 has a 68000 microprocessor that can support up to 5MB of memory and up to 40MB of on-line disk storage. $21,130.



Atasi's PC/AT SpeedStor Kit

CTI-130 from Chase Technologies

IBM Corporation, Information Systems Group, 900 King Street, Rye Brook, NY 10573; 914/934-4488

CIRCLE 308 ON READER SERVICE CARD

Two new video boards for the PC, PC/XT, PC/AT, and compatibles have been introduced by **STB Systems, Inc.** The **Chauffeur**, built for IBM monochrome monitors, displays color/graphics software in a full-screen format, without any software modifications. Colors are converted to a 16-level gray scale. **SUPER RES 400** maintains standard IBM compatible color graphics capabilities while providing the added benefit of high-resolution, monochrome-quality text display. Both are packaged with PC Accelerator software. Chauffeur includes a parallel port and an optional clock/calendar. Chauffeur, $395; SUPER RES 400, $595.
STB Systems, Inc., 601 N. Glenville, Suite 125, Richardson, TX 75081; 214/234-8750

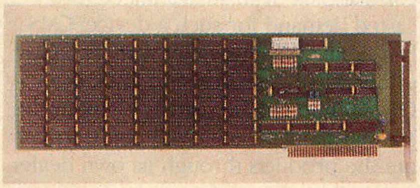
CIRCLE 316 ON READER SERVICE CARD

Available from **Chase Technologies, Inc.** is the **CTI-130**, a 130MB, five-and-one-fourth-inch high performance disk drive. Made for the PC/AT environment, CTI-130 is compatible with most LANs. It features a 17-millisecond average access time and a data transfer rate of 1.21MB/second. On-board diagnostics allow it to monitor reads, seeks, and rotational speed. The CTI-130 is being shipped as a kit for the AT or stand-alone. All CTI drives are available with optional file-oriented streaming tape or nine-track tape backup, uninterruptible power supply and CTI-PS (power sequencer) with key switch control, surge suppressor, and computerized power on/off sequencing. CTI-130 AT kit, $6,995; CTI-130 stand-alone drive, $7,595; call the company for information on options.
Chase Technologies, Inc., 375 Sylvan Avenue, Englewood Cliffs, NJ 07632; 201/894-5544

CIRCLE 310 ON READER SERVICE CARD

The **GRIZZLY 64-512KB RAM Board** has been announced by **Helix Technology.** New for the PC/XT and compatibles, GRIZZLY operates with reduced components and on two different frequencies, 4.77 or 7.16 mHz; it adjusts automatically. GRIZZLY comes fully socketed; no additional socketing is needed. $120; each additional 64KB, $30.
Helix Technology, Inc., 8123-25 Remmet Avenue, Canoga Park, CA 91304; 818/710-0300

CIRCLE 312 ON READER SERVICE CARD


GRIZZLY by Helix Technology

The **ATASI PC/AT SpeedStor Kit** provides more than double the storage of the IBM factory hard disk while increasing system throughput by 30 percent. The kit includes the following: the ATASI 3051 Winchester disk drive, integration software, mounting hardware, data cable, and instruction manual. The software's intelligent partitioner provides the option for up to four PC-DOS partitions; the SpeedStor offers a 28-millisecond average access time with two 21MB partitions. $2,495.
ATASI Corporation, 2075 Zanker Road, San Jose, CA 95131; 408/436-2350

CIRCLE 313 ON READER SERVICE CARD

Edsun Laboratories has announced the availability of the **EL286-88** processor converter chip. The EL286-88 is an application-specific VLSI integrated circuit that converts the signals of an 80286 processor into the equivalent signals of an 8088 processor. By mixing 16-bit main memory with access to 8-bit peripherals, a manufacturer can provide fast program execution and a wide variety of low-cost I/O. The EL286-88 translates data width, control signals, and circuit timing. No software changes are required: except for changes in the execution speed, the translation is undetectable to the software. $61.
Edsun Laboratories, Inc., 7 Sears Road, Wayland, MA 01778; 617/358-5667

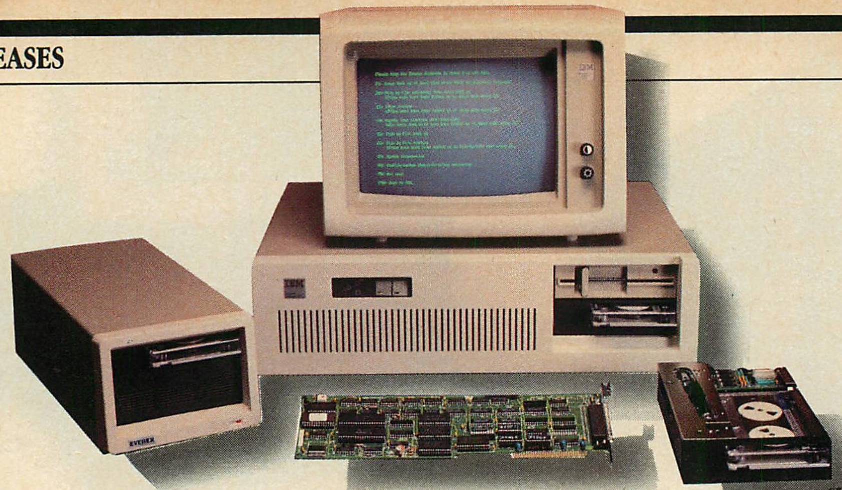
CIRCLE 311 ON READER SERVICE CARD

Flagstaff Engineering now offers a solution to the problem of moving text documents written on diskette between incompatible word processing systems. **WORD CONNECTION** is a set of programs with the ability to read and write text documents from most word processing systems using a PC, PC/XT, PC/AT, or compatible equipped with Flagstaff's **DISKETTE CONNECTION** eight-inch drive systems. Written in assembly language, WORD CONNECTION programs transfer documents to a DOS file using IBM's Revisable Form Text standards for document architecture. WORD CONNECTION, $1,100; DISKETTE CONNECTION, $695.
Flagstaff Engineering, Inc., P. O. Box 1970, Flagstaff, AZ 86002; 602/774-5188

CIRCLE 309 ON READER SERVICE CARD

The **Companion 34LQ** printer, a 132-column, dot-matrix printer that produces letter-quality printing at speeds of up to 60 characters per second, has been announced by **Xerox Corporation**. In the draft-quality mode, the 34LQ can operate at speeds of up to 270 characters per second. The Companion 34LQ has a dual interface, serial and parallel, and operates in both a Diablo 630 mode with extended-character-set capability and an alternate, IBM-compatible mode. Designed for use with the 34LQ, the **F24** is a new two-bin feeder for dot-matrix printers. Companion 34LQ, $1,595; F24, $893.
Xerox Corporation, Xerox Square 006, Rochester, NY 14644; 716/423-5078

CIRCLE 319 ON READER SERVICE CARD



The Everex Family

Universal Data Systems has introduced the **14.4 Trellis**, a modem that operates at 14,400 bits per second (bps) over unconditioned private lines. Available in both a compact stand-alone package and a 58-square-inch card, the 14.4 Trellis provides for fallback rates of 12,000 and 9,600 bps. A fully automatic adaptive equalizer compensates for any line distortions without manual strapping of pre-equalizers. $3,950.
Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805-1953; 205/837-8100
CIRCLE 315 ON READER SERVICE CARD

Universal Data Systems' 14.4 Trellis

Everex Systems, Inc. has introduced several products. The **APEX MEG-1000** and the **EXCEL 4500** are one-fourth-inch streaming tape back-up systems, providing respectively 100MB and 45MB of back-up capacity. The EXCEL 4500 plugs right into the PC/AT, PC/XT, or PC. Everex's **EXCEL XT-200** cassette back-up system also plugs right into the unit; it can back up 20MB of information. The three systems permit backing up information with a "mirror image" method and file-by-file retrieval for a much faster process. Another product introduced is **The Edge** color/monochrome graphics adapter. It runs color graphics software on the IBM monochrome display, operates popular programs in an extended 132-column display, runs high-resolution text and graphics with both color and monochrome monitors, provides a flicker-free display, and connects a printer to the computer. APEX MEG-1000, $1,895; EXCEL 4500, $1,195; EXCEL XT-200, $895; The Edge, $389.
Everex Systems, Inc., 47777 Warm Springs Blvd., Freemont, CA 94539; 415/498-1111
CIRCLE 317 ON READER SERVICE CARD

Colorado Memory Systems (CMS) has introduced the **QIC-60**, a family of QIC-compatible, one-fourth-inch tape and combination tape/Winchester subsystems for the PC, PC/XT, PC/AT, and compatibles. With substantiated forecasted demand for such a device, CMS has signed an agreement with **Tecmar** under which, according to CMS, the QIC-60 line will be marketed under the Tecmar label. Tecmar will also distribute the products through its own dealer network, and manufacture under license to CMS. Initially, a 60MB tape-only subsystem, $2,144, and a combination 60MB tape and 20MB Winchester drive unit, $3,495, will be offered.
Colorado Memory Systems, Inc., 800 S. Taft Avenue, Loveland, CO 80537; 303/669-8000
CIRCLE 345 ON READER SERVICE CARD

Tecmar, 625 Cochran Road, Solon, OH 44139; 216/349-0600
CIRCLE 318 ON READER SERVICE CARD

ADIC has announced a high-capacity, file-addressable tape cartridge back-up system for networked PCs: the **Data Library.** Cartridges for the Data Library have a formatted capacity of 134MB, 32 tracks, and more than 140,000 addressable blocks. Capable of storing more than 30,000 DOS files, Data Library emulates a hard disk and uses all MS-DOS commands. Data integrity is a key feature; tapes are internally certified and verified. Cartridges are interchangeable from system to system. $4,495.
ADIC, P.O. Box 2996, Redmond, WA 98013; 800/638-0818 or 206/881-8004
CIRCLE 338 ON READER SERVICE CARD

Several new printers have been introduced by **Epson America, Inc.** The **FX-80+** is an 80-column, high-performance, bi-directional dot-matrix printer that adds a SelecType feature and the ability to accept LetterType (NLQ) boards to the features of the FX-80. The **FX-100+** offers the same wide range of print features as the original FX-100 model with improvements in speed, versatility, and ease of use. These two printers offer a speed of 160 characters per second and a 20 percent improvement in throughput.

The **JX-80** is a high-performance, dot-matrix printer that offers printing in as many as seven colors at a speed of 160 characters per second. A single-color black ribbon can be substituted for the color ribbon when desired. Users can optionally download special fonts from their computer systems into the JX-80's memory. FX-80+, $499; FX-100+, $699; JX-80, $699.
Epson America, Inc., Computer Products Division, 2780 Lomita Blvd., Torrance, CA 90505; 800/421-5426 or 213/539-9140 (in California)
CIRCLE 320 ON READER SERVICE CARD

A new voice recognition box for the PC and compatibles has been announced by **Interstate Voice Products.** The **CSRB240** offers connected speech recognition capabilities that eliminate the need for pauses between utterances, allowing users to input data in a more natural speaking style. It permits the user to structure a vocabulary of 15 to 20 words. This vocabulary may be used in conjunction with a 240-word vocabulary of discretely uttered words. When used in this manner, user-defined key vocabularly commands evoke connected speech algorithms embodied in the firmware. $1,650.
Interstate Voice Products, 1849 W. Sequoia Avenue, Orange, CA 92668; 714/937-9010
CIRCLE 339 ON READER SERVICE CARD

MOST SIGNIFICANT PRODUCT OF THE YEAR - PC WEEK

They said it couldn't be done. Borland Did It. Turbo Pascal 3.0

The industry standard

With more than 250,000 users worldwide Turbo Pascal is the industry's de facto standard. Turbo Pascal is praised by *more* engineers, hobbyists, students and professional programmers than any other development environment in the history of microcomputing. And yet, Turbo Pascal is simple and fun to use!

	TURBO 3.0	TURBO 2.0	MS PASCAL
COMPILATION SPEED	8.1	16	206
EXECUTION SPEED	9 SEC	13 SEC	20 SEC
CODE SIZE	12 K	12 K	35 K
BUILT-IN INTERACTIVE EDITOR	YES	YES	NO
ONE STEP COMPILE (NO LINKING NECESSARY)	YES	YES	NO
COMPILER SIZE	39K	35K	300K+
TURTLE GRAPHICS	YES	NO	NO
BCD OPTION	YES	NO	YES
PRICE	$69.95	$54.95	$295.00

(*) **Benchmark** run on an IBM PC using MS Pascal version 3.2 and the DOS linker version 2.6. The 179 line program used is the "Gauss-Seidel" program out of Alan R. Miller's book: *Pascal programs for scientists and engineers* (Sybex, page 128) with a 3 dimensional non-singular matrix and a relaxation coefficient of 1.0.

The best just got better: Introducing Turbo Pascal 3.0

We just added a whole range of exciting new features to Turbo Pascal:

- First, the world's fastest Pascal compiler just got faster. Turbo Pascal 3.0 (16 bit version) compiles twice as fast as Turbo Pascal 2.0! No kidding.
- Then, we totally rewrote the file I/O system, and we also now support I/O redirection.
- For the IBM PC versions, we've even added "turtle graphics" and full tree directory support.
- For all 16 Bit versions, we now offer two additional options: 8087 math coprocessor support for intensive calculations and Binary Coded Decimals (BCD) for business applications.
- And much much more.

The Critics' Choice.

Jeff Duntemann, PC Magazine: *"Language deal of the century . . . Turbo Pascal: It introduces a new programming environment and runs like magic."*

Dave Garland, Popular Computing: *"Most Pascal compilers barely fit on a disk, but Turbo Pascal packs an editor, compiler, linker, and run-time library into just 39K bytes of random-access memory."*

Jerry Pournelle, BYTE: *"What I think the computer industry is headed for: well documented, standard, plenty of good features, and a reasonable price."*

Portability.

Turbo Pascal is available today for most computers running PC DOS, MS DOS, CP/M 80 or CP/M 86. A XENIX version of Turbo Pascal will soon be announced, and before the end of the year, Turbo Pascal will be running on most 68000 based microcomputers.

An Offer You Can't Refuse.

Until June 1st, 1985, you can get Turbo Pascal 3.0 for only $69.95. Turbo Pascal 3.0, equipped with either the BCD or 8087 options, is available for an additional $39.95 or Turbo Pascal 3.0 with both options for only $124.95. As a matter of fact, if you own a 16-Bit computer and are serious about programming, you might as well get both options right away and save almost $25.

Update policy.

As always, our first commitment is to our customers. You built Borland and we will always honor your support.

So, to make your upgrade to the exciting new version of Turbo Pascal 3.0 easy, we will accept your original Turbo Pascal *disk* (in a bend-proof container) for a trade-in credit of $39.95 and your Turbo87 original *disk* for $59.95. This trade-in credit may only be applied toward the purchase of Turbo Pascal 3.0 and its additional BCD and 8087 options (trade-in offer is only valid directly through Borland and until June 1st. 1985).

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The disk size I use is: ☐ 3½" ☐ 5¼" ☐ 8"

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Pascal w/8087 $109.90 ______

Pascal w/BCD $109.90 ______

Pascal w/8087 & BCD $124.95 (SAVE $24.90) ______

*These prices include shipping to all U.S. cities. All foreign orders add $10 per product ordered.

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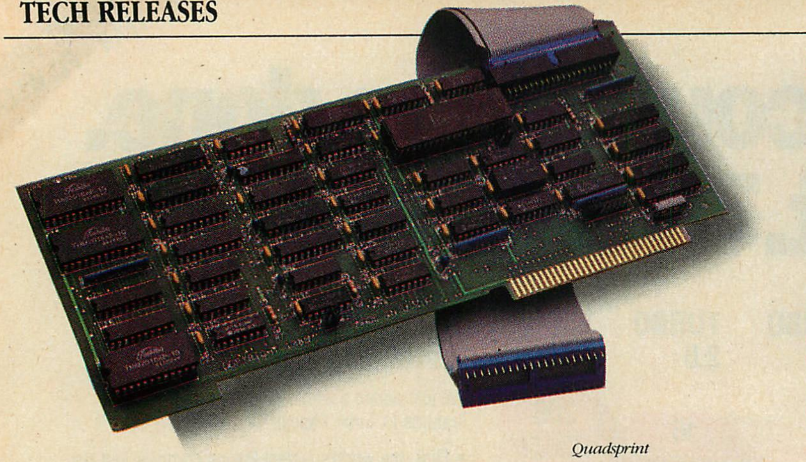
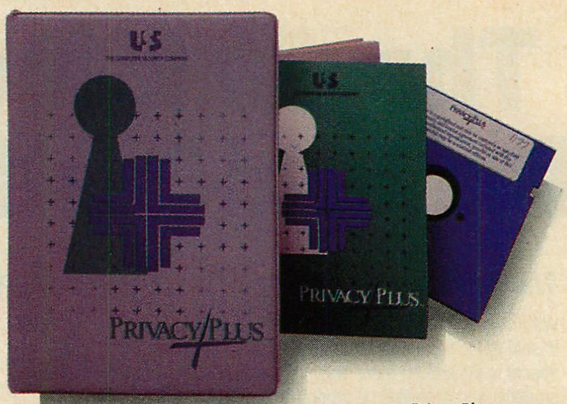


Quadsprint



PrivacyPlus

Quadram Corporation has announced the availability of three products: **Quadsprint**, a speed enhancement processor board for the PC and compatibles; **Quadscreen**, a bit-mapped, big-screen monochrome monitor for CAD/CAM applications; and **Palette Master**, a high-resolution color graphics adapter. Quadsprint has a 10-mHz 8086 chip with 4KB of high-speed memory cache; existing memory is not affected by its installation. Quadscreen has a 17-inch screen with a 968-by-512 dot resolution and is controlled by a flicker-free board. Palette Master can display 256 colors from a palette of 256,000 in a 320-by-200 dot image. Quadsprint, $645; Quadscreen, $1,995; Palette Master, $695.
Quadram Corporation, 4355 International Blvd., Norcross, GA 30093; 404/923-6666

CIRCLE 314 ON READER SERVICE CARD

SOFTWARE

Digital Research Inc. has introduced its first end-user applications programs that take full advantage of the Graphics Environment Manager (GEM) operating system extension—**GEM Desktop** and **GEM Draw**. Also announced were two new GEM software applications, **GEM Paint** and **GEM Write**, which will be bundled as the **GEM Collection** with GEM Desktop. GEM Desktop and GEM Draw bring to the PC and compatibles drop-down menus, windows, icons, and support for a mouse pointing device. GEM Desktop replaces operating system commands with a visual, intuitive interface. GEM Draw is a graphics editor that produces organizational charts, flow charts, company logos, and other pictorials. GEM Desktop, $49.95; GEM Draw, $149.00 until August 31, 1985, then $249.00; GEM Collection, $199.00.
Digital Research, Inc., Box DRI, Monterey, CA 93942; 800/443-4200

CIRCLE 321 ON READER SERVICE CARD

Rtrieve is a full-featured, menu-driven report writer from **SoftCraft Inc.** that allows data to be generated in any user-defined format for custom-designed reports, form letters, statements, and other applications. Rtrieve is a new member to the Btrieve family of relational database management software. With Rtrieve, the user first selects the information that will be displayed in the report with Xtrieve's restriction criteria; it then displays a menu of field names to be included in the report. The user formats the report by positioning the fields on the CRT screen. Single-user version, $85; LAN version, $175.
SoftCraft Inc., P. O. Box 9802, #917, Austin TX 78766; 512/346-8380

CIRCLE 326 ON READER SERVICE CARD

Ryan-McFarland Corporation has announced that IBM Corporation is marketing the latest version of RMCOBOL for the PC/IX operating system, available for the PC, PC/XT, PC/XT-370, and PC/AT. **IX RMCOBOL** makes accessible more than 2,000 RMCOBOL-based business applications and development/productivity tools to PC/IX users. RMCOBOL is also now available for the PC/AT running under Microsoft's XENIX.

In addition, the company has announced the availability of **RMBASIC**, a business-oriented BASIC for the PC family and compatibles running PC-DOS. RMBASIC has capabilities characteristic of most BASIC implementations on other IBM computers and is intended to open up to PC users the more sophisticated BASIC applications already in use on IBM machines from mainframes to minicomputers to smaller machines like the System/23. IX RMCOBOL full system, $750; runtime, $230 (contact IBM). RMCOBOL for XENIX on the AT, $1,250 (contact Ryan-McFarland). RMBASIC, $600 (contact Ryan-McFarland).
IBM Direct, 1 Culver Road, Dayton, NJ 08810; 800/426-2468

CIRCLE 346 ON READER SERVICE CARD

Ryan-McFarland Corporation, 609 Deep Valley Drive, Rolling Hills Estates, CA 90274; 213/541-4828

CIRCLE 325 ON READER SERVICE CARD

From **United Software Security, Inc.** comes **PrivacyPlus**, a product that secures data using either the Data Encryption Standard (DES) or a faster encryption method designed by USS. It locks files, texts, and programs on hard and floppy disks and protects data on PCs, electronic mail, LANs, and other environments. PrivacyPlus uses straightforward English commands such as Lock and Unlock, and offers a small, easy-to-read user guide. In addition, it protects against user typing errors, inadvertent locking of previously locked files, unlocking with invalid passwords, and accidental deletion of files. $159; Site License Annual Fee, $800; Corporate License Annual Fee, $2,400.
United Software Security, Inc., 6867 Elm Street, Suite 100, McLean VA 22101; 703/556-0007

CIRCLE 322 ON READER SERVICE CARD

The **Demo Generator** is a high-performance industrial tool for production of high-quality, PC-based commercials ("demos") and tutorials. Developed by **Trillian Computer Corporation** and intended for use by the computer industry for product promotion and support, Demo Generator can be used for such promotionals as trade shows, dealers, or direct mail. Demo Generator-produced presentations can be self-running or interactive; they run on a PC, PC/XT, or PC/AT in color, with graphics, sound, and animation. Demos can run in parallel with the software being demonstrated. Annual license fee, $6,800 (includes four hours of on-site training); source code license is available.
Trillian Computer Corporation, 405 Alberto Way, Suite 1, Los Gatos, CA 95030; 408/358-2761

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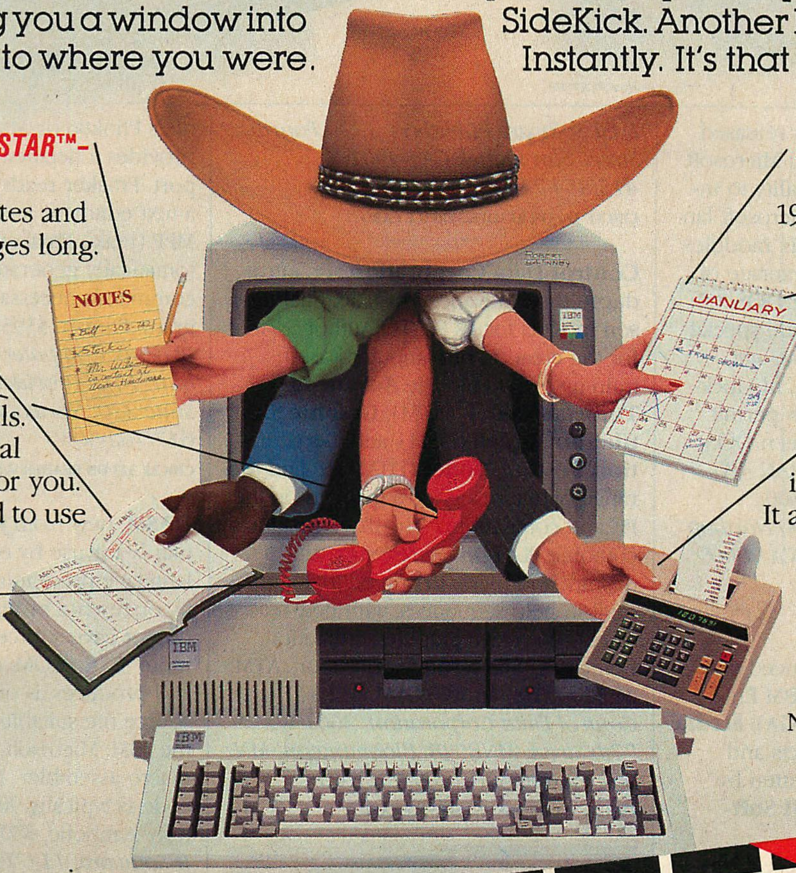
INFOWORLD'S SOFTWARE PRODUCT OF THE YEAR

Borland's SideKick™ Will Clear Your Desk In 30 Minutes And Increase Your Productivity By 50%

SideKick is a combination of seven desktop accessories, which makes SideKick the single most effective business tool. Just a keystroke suspends your application program, giving you a window into SideKick. Another keystroke brings you back to where you were. Instantly. It's that easy.



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"SIDEKICK deserves a place in every PC." **Garry Ray, PC WEEK**

"SIDEKICK is by far the best we've seen. It is also the least expensive." **Ron Mansfield, ENTREPRENEUR**

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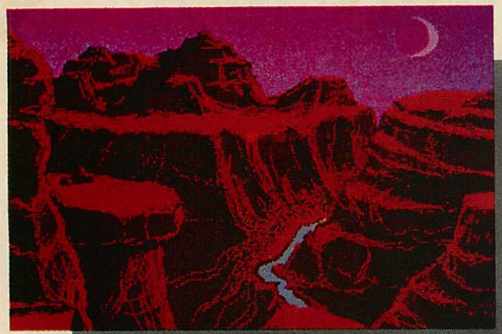
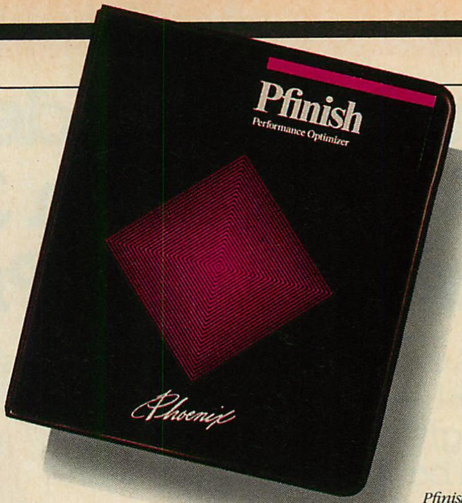


PCPaintbrush screen



Pfinish by Phoenix

Microsoft Corporation has released Microsoft **FORTRAN 3.3** and Microsoft **Pascal 3.3**. Both have the ability to interface directly with other Microsoft languages: programmers can mix modules among languages to take advantage of the best features of each. For DOS 3.0 users, the new releases include special features that support multiuser networks, including file sharing, file locking, and record locking. Both permit transporting languages between DOS and XENIX. Microsoft FORTRAN 3.3, $350; Microsoft Pascal 3.3, $300. *Microsoft Corporation, 10700 Northup Way, Box 97200, Bellevue, WA 98009; 206/828-8080*

CIRCLE 324 ON READER SERVICE CARD

Two companies have announced that their products support the IBM Enhanced Graphics Adapter (EGA): **Media Cybernetics' HALO** products and **PCPaintbrush**, which is written by **ZSoft** and published by **IMSI Software Publishers**.

With HALO, users can access the 640-by-350 high-resolution mode. The HALO device driver for the EGA, which replaces five IBM drivers, requires less storage than any one of the individual IBM drivers. HALO is a graphics subroutine library that forms the foundation for a number of graphics software packages. HALO, $99.95; $25.00 for update.

PCPaintbrush is a full-color, mouse-driven paint program for the PC and compatibles; a few of its features are pull-down menus, multiple text fonts, and drawing tools. Graphics and text can be transferred to PCPaintbrush to be enhanced, manipulated, and printed. PCPaintbrush will run on any color card with IBM's standard 320-by-200, four-color mode. $139.00; lifetime update fee, $50.00, or $15.00 per update. *Media Cybernetics, Inc., 7050 Carroll Avenue, Takoma Park, MD 20912; 301/270-0240*

CIRCLE 347 ON READER SERVICE CARD

IMSI Software Publishers, 1299 Fourth Street, San Rafael, CA 94901; 415/454-7101

CIRCLE 329 ON READER SERVICE CARD

Control Data Corporation has introduced three advanced instructional lesson models for its PLATO Author System for the creation of computer-based training programs. The **Advanced Tutorial Model** (ATM), **Graphic Simulation Model**, (GSM), and **Certification Testing Model** (DTM) expand the range of authoring tools that run on the PC and compatibles. The three products combine PLATO features, such as prompt and menu-driven editors and built-in help sequences, with new features—extensive graphics, animation, branching, and testing verification. ATM, $6,500; CTM, $6,500; GSM, $12,000. *Control Data Corporation, 3601 W. 77th Street, MNB048, Bloomington, MN 55435; 800/328-1109, ext. 100*

CIRCLE 333 ON READER SERVICE CARD

Control Data's Advanced Tutorial Model

Pfinish, a programming tool designed to maximize program efficiency by increasing execution speed and reducing memory requirements, and **Pmaker**, a program development manager for MS-DOS and PC-DOS, have been introduced by **Phoenix Computer Products Corporation**. Pfinish accesses symbol table information, overlays, and interrupts to produce a meaningful analysis; it works off the symbol table information provided by either Phoenix's Plink86 or Microsoft LINK. Pfinish provides a detailed, comprehensive report. Pmaker reads text files created by a text editor or its own menu-driven MPF (make Pmaker file) utility. MPF automatically generates all of the Pmaker commands necessary to produce a program. Pfinish, $395; Pmaker, $395. *Phoenix Computer Products Corporation, 1416 Providence Highway, Suite 220, Norwood, MA 02062; 617/762-5030*

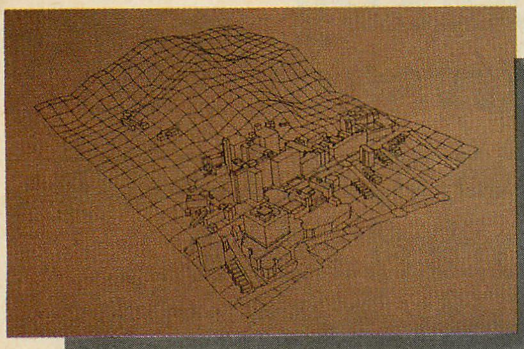
CIRCLE 323 ON READER SERVICE CARD

DASM, new from **JBSoftware**, is primarily for use by experienced assembly language programmers wishing to modify or rewrite programs for which they do not have source code. It accepts as input .EXE, .COM, and other run files, and produces as output an assembly source file suitable for reassembly by the IBM, Microsoft, or a compatible macro assembler. DASM's output source code is typically 90 percent or more fully symbolic. $50. *JBSoftware, 113 W. Monument Street, Baltimore, MD 21201; 301/539-2616*

CIRCLE 327 ON READER SERVICE CARD

Pro/Am Software has announced a new version of its fully-labelling disassembler called **PC-DISnDATa**. Its capabilities include: an ability to disassemble both .EXE and .COM files; recursion instruction flow trace and segment register data trace to determine the extent of program SEGMENTs, PROCs, and data areas (including those within 'CODE' areas); identification and output of data areas using the appropriate form of the DB or DW pseudo-ops; and an ability to choose DB/DW data widths to match the byte or word data references within the code itself. PC-DISnDATa runs on the PC/XT and compatibles with 128KB, one or more disks, and DOS 2.x. $145. *Pro/Am Software, 220 Cardigan Road, Centerville, OH 45459; 513/435-4480*

CIRCLE 328 ON READER SERVICE CARD



XYZ-3D screen

X-STAT by Wiley

Aariac Corporation's XYZ-3D, a sophisticated graphics program developed in the early 1970s for mainframes, is now available for the PC. Users can move, rotate, or scale specific structures in a project, and make copies and mirror images of them in new locations. XYZ-3D includes a three-dimensional character set that can be used to write words in space. It produces true perspective drawings, two-point perspective drawings, orthographic projections, isometric views, and cross sections via its exact visual simulation. Successive pictures can show how a project would look if the user zoomed in on it and walked around or through it. Single-user version, $795; LAN version, $1,995; demonstration package, $95.
Aariac Corporation, 5630 Arbor Vitae, Los Angeles, CA 90045; 213/568-0006
CIRCLE 330 ON READER SERVICE CARD

With **VDTE 2.1**, from **Inner Loop Software**, the PC is able to emulate the HP2624, HP2648, and VT52 type video display terminals, making available most HP1000 and HP3000 software. Menu-driven operations are selected using the PC's function keys. The desired terminal configuration is entered once: VDTE 2.1 remembers it for re-use. Other features include support for both serial ports simultaneously, 14 pages of offscreen scrolling memory, and 10 communications speeds. The HP line-drawing character set is supported; the characters are mapped onto their closest PC equivalents. VDTE 2.1 works with the IBM/Epson printer or similar matrix printers. $200.
Inner Loop Software, 5456 McConnell Avenue, Suite 120, Los Angeles, CA 90066; 213/822-2800
CIRCLE 335 ON READER SERVICE CARD

Attachmate Corporation has announced a 3270-PC **DFT-Windowing Emulation** program for use with IBM's 3278/79 Emulation Adapter on the PC. The product gives a standard PC or compatible the functional benefits of the 3270-PC. Functions include four 3270 terminal windows, two notepad windows, and a DOS window. Users can run four different applications, each in its own window, and the program is multitasking, permitting uninterrupted use of the PC session. Attachmate also emulates 3287 printers. $550.
Attachmate Corporation, 3241 118th S.E., Bellevue, WA 98005; 206/644-4010
CIRCLE 336 ON READER SERVICE CARD

Wiley Professional Software has announced several new products. **Steamcalc, Gasprops, Curvfit, Fluidflo, Heatflo**, and **Combustion**, developed by Software Systems, are powerful, easy-to-use, performance-tested technical analysis tools for the PC and compatibles. Each computes and analyzes the specific physical properties that its name suggests. The programs feature step-by-step input and a data recycle capability that permits computation of "what if" studies in seconds.

The **C Language Scientific Subroutine Library**, developed by Peerless Engineering Service, provides PC users with 112 precompiled mathematical and statistical subroutines. Supplied on disk as a linkable library and source code, it includes operations for polynomials, differentiation, probability, and interpolation.

X-STAT, by Softpower Inc., is an applied statistics package designed specifically for scientists and engineers who develop products and processes through laboratory research; it emphasizes experiment design prior to conducting analysis. Prices: Steamcalc, Gasprops, Fluidflo, and Heatflo, $300 each; Curvfit, $195; Combustion, $450; C Language Library, $175; X-STAT, $350.
Wiley Professional Software, 605 Third Avenue, New York, NY 10158; 212/850-6009
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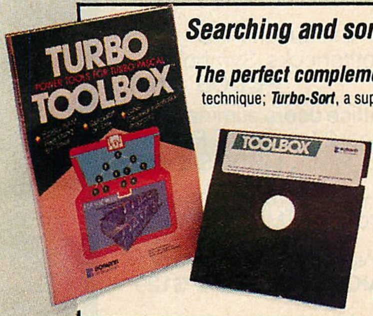

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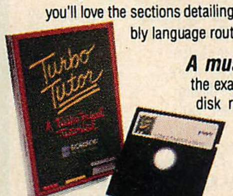

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TECH NOTEBOOK 43

TED FORGERON

The Disappearing Cursor

All the clues needed to solve the mystery of making the cursor disappear are in the IBM Technical Reference Manual.

Sometimes applications need to disable the ever-present, blinking cursor. The artistry of a sophisticated character-graphics screen can be spoiled by a cursor flashing irreverently in the upper left corner.

Two of the BIOS video I/O routines in the *IBM Technical Reference Manual* may be helpful in snuffing out the cursor. The first routine sets the cursor *type*; it tells the BIOS whether the cursor is fat, skinny, a dash, or an underline. The second routine sets the cursor *position*.

The listing below, NOCURSOR.ASM, contains three different assembly language routines to make the cursor disappear. CURSOR_HIDE uses the BIOS set-cursor-position routine to move the cursor one line below the bottom of the screen. This method works for stand-alone programs but causes problems with IBM's window manager, TopView, which occasionally scrolls the screen up to reveal the hiding cursor.

CURSOR_SHRINK uses the BIOS set-cursor-type routine to convince the hardware that the cursor starts and stops on nonexistent scan lines. Normally, individual characters occupy scan lines 0 through 13 on the monochrome monitor, and 0 through 7 on the color adapter. CURSOR_SHRINK, however, tricks the BIOS into thinking that the cursor starts and stops on scan line 14 for the monochrome adapter and scan line 8 for the color adapter. Unfortunately, CURSOR_SHRINK has some reliability problems. With some monitor adapters, the program intermittently causes the cursor to appear as a solid, blinking box, instead of invisible as is intended.

CURSOR_DISAPPEAR is the technique that works best. A comment in the manual warns that setting bits 5 or 6 in the cursor start parameter of the set-cursor-type routine "will cause erratic blinking or no cursor at all." Careful experimentation shows that when bit 5 is on and bit 6 is off, the cursor simply disappears with no negative side effects.

Ted Forgeron is vice-president of systems software engineering at Multisoft Corporation located in Beaverton, Oregon.

LISTING: NOCURSOR.ASM

```
        TITLE   NOCURSOR -- Making the Cursor Disappear.

TRUE            EQU     01H             ; boolean true
FALSE           EQU     00H             ; boolean false
VIDEO_IO        EQU     10H             ; BIOS video I/O routine
SET_CURSOR_TYPE EQU     01H             ;  cursor type option
SET_CURSOR_POS  EQU     02H             ;  cursor positon opt

NOCURSOR SEGMENT PUBLIC 'CODE'
        ASSUME CS:NOCURSOR
        ASSUME DS:NOTHING

COLOR_ADAPTER   DB      TRUE            ; change if you have mono

; CURSOR_HIDE hides the cursor by telling the BIOS to
; position it one line below the bottom of the display.

        PUBLIC  CURSOR_HIDE
CURSOR_HIDE     PROC FAR
        PUSH    AX                      ; save registers
        PUSH    DX
        PUSH    BX
        MOV     DH,25                   ; set row for cursor
        MOV     DL,0                    ; set column for cursor
        MOV     BH,0                    ; set video page
        MOV     AH,SET_CURSOR_POS       ; cursor position option
        INT     VIDEO_IO                ; call BIOS video I/O
        POP     BX                      ; restore registers
        POP     DX
        POP     AX
        RET
CURSOR_HIDE     ENDP

; CURSOR_SHRINK shrinks the cursor down to nothing by telling
; BIOS that the cursor starts and stops on scan line 14 for the
; monochrome adapter and scan line 8 for the color adapter.

        PUBLIC  CURSOR_SHRINK
CURSOR_SHRINK   PROC FAR
        PUSH    AX                      ; save registers
        PUSH    CX
        MOV     CH,0EH                  ; cursor start reg: mono
        MOV     CL,0EH                  ; cursor end reg : mono
        CMP     COLOR_ADAPTER,TRUE      ; color adapter active?
        JNE     C1                      ; no, mono start & end
        MOV     CH,08H                  ; cursor start reg: color
        MOV     CL,08H                  ; cursor end reg: color
C1:     MOV     AH,SET_CURSOR_TYPE      ; set cursor type option
        INT     VIDEO_IO                ; call BIOS video I/O
        POP     CX                      ; restore registers
        POP     AX
        RET
CURSOR_SHRINK   ENDP

; CURSOR_DISAPPEAR reliably makes the cursor disappear by using
; an undocumented feature of the BIOS video routine.

        PUBLIC  CURSOR_DISAPPEAR
CURSOR_DISAPPEAR PROC FAR
        PUSH    AX                      ; save registers
        PUSH    CX
        MOV     CH,00100000B            ; bit 5 on, bit 6 off
        MOV     AH,SET_CURSOR_TYPE      ; set cursor type option
        INT     VIDEO_IO                ; call BIOS video I/O
        POP     CX                      ; restore registers
        POP     AX
        RET
CURSOR_DISAPPEAR ENDP

NOCURSOR ENDS
        END
```

TOM SWAN

Comparing Structures

This routine permits Turbo Pascal to compare two structured variables.

Turbo Pascal does not allow direct comparisons to be made of two structured variables. For example, the following statement would *not* work in Turbo Pascal with two records that are named R1 and R2:

```
IF R1 = R2
   THEN WRITELN( 'Records are equal' )
   ELSE WRITELN( 'Records are not equal' );
```

Trying to compile that statement will result in error message 62, "Structured variables are not allowed here. Press <esc>." To get around this error, the usual solution is to compare each record field separately. If R1 and R2 have three fields, **name**, **age**, and **address**, then the faulty IF statement might be rewritten in the following way:

```
IF ( R1.NAME = R2.NAME) AND
   ( R1.AGE = R2.AGE) AND
   ( R1.ADDRESS = R2.ADDRESS )
   THEN WRITELN( 'Records are equal' )
   ELSE WRITELN( 'Records are not equal' );
```

Although this solution works, it tends to be cumbersome for records with more than a few fields. An alternative to the above solution is demonstrated in the program **compare.pas**. Function **equalrecs** accepts two variables, **r1** and **r2**, and returns **true** if the records are equal; **false** if not. Inside the function are two variables, **v1** and **v2**, that, with the help of Turbo's **absolute** modifier, are overlayed at the same addresses of parameters **r1** and **r2**. By declaring **v1** and **v2** as arrays of bytes, the compiler is fooled into treating the passed parameters as byte arrays instead of structured records. Comparing the two records is reduced to a simple FOR loop to check all bytes of **r1** against **r2**.

The **comparerec** procedure demonstrates how to use the new **equalrecs** function. When the program is run, three pairs of records will appear, with a message indicating whether or not the records are equal.

To add **equalrecs** to a program, change the **rec** type to any structured data type. This change must be made in two places—in the parameter list of the **equalrecs** function and in the **sizeof** function in the FOR loop.

Tom Swan runs his own consulting business, Swan Software. He is the author of four books published by the Hayden Book Company, most recently, Pascal Programs for Data Base Management.

LISTING: compare.pas

```
PROGRAM compare;
{---------------------------------------------------------}
{ How to compare two structured variables for equality, an    }
{ operation not normally allowed in Turbo Pascal. By Tom Swan }
{---------------------------------------------------------}

TYPE
   string20 = string[20];
   rec      = record
                 name : string20;
                 age : integer;
                 elected : integer;
              end;
VAR
   r1, r2, r3 : rec;

FUNCTION equalrecs( VAR r1, r2 : rec ) : boolean;
{  function returns true if r1 = r2.                  }
{ "rec" may be changed to any type in the parameter list }
{    above and in the FOR loop below.                  }
TYPE
   image = ARRAY[ 1 .. maxint ] OF BYTE;
VAR
   v1 : image absolute r1;
   v2 : image absolute r2;
   i  : integer;
BEGIN
   equalrecs := true;
   FOR i := 1 TO sizeof( rec ) DO
      IF v1[i] <> v2[i]
         THEN equalrecs := false
END; { equalrecs }

PROCEDURE comparerecs( VAR r1, r2 : rec );
{ Display and compare two structured records }
CONST
   separator = '----------------------------';
BEGIN
   writeln;
   writeln( separator );
   writeln( r1.name:12, r2.name:12 );
   writeln( r1.age:12, r2.age:12 );
   writeln( r1.elected:12, r2.elected:12 );
   write( 'Records are ' );

   IF not equalrecs( r1, r2 )  { Compare records }
      THEN write( 'NOT ' );

   writeln( 'equal' );
   writeln( separator )
END; { comparerecs }

BEGIN
   r1.name := 'R. Reagan'; r1.age := 74; r1.elected := 1980;
   r2.name := 'J. Carter'; r2.age := 61; r2.elected := 1976;
   r3 := r1;
   comparerecs( r1, r2 );
   comparerecs( r2, r3 );
   comparerecs( r1, r3 )
END.
```

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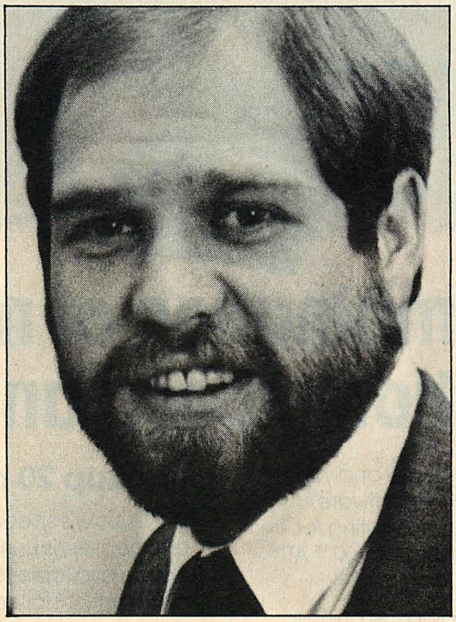

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DOS/Tape Utility Toggling	✓				
Mouse-like Command Input	✓				
DOS-like Tape Directory Commands	✓				
Backup/Restore Time & Percentage Indicator	✓				% only
Image Backup/File by File Restore with Directory Display	✓				✓
File by File Backup/Restore by Directory or Subdirectory	✓	✓	✓	✓	
File by File Backup/Restore by Date or Last Modified	✓	✓	✓	✓	
File by File Backup/Restore with Appending & Exclusion	✓		✓		
File by File Restore to any Directory	✓				
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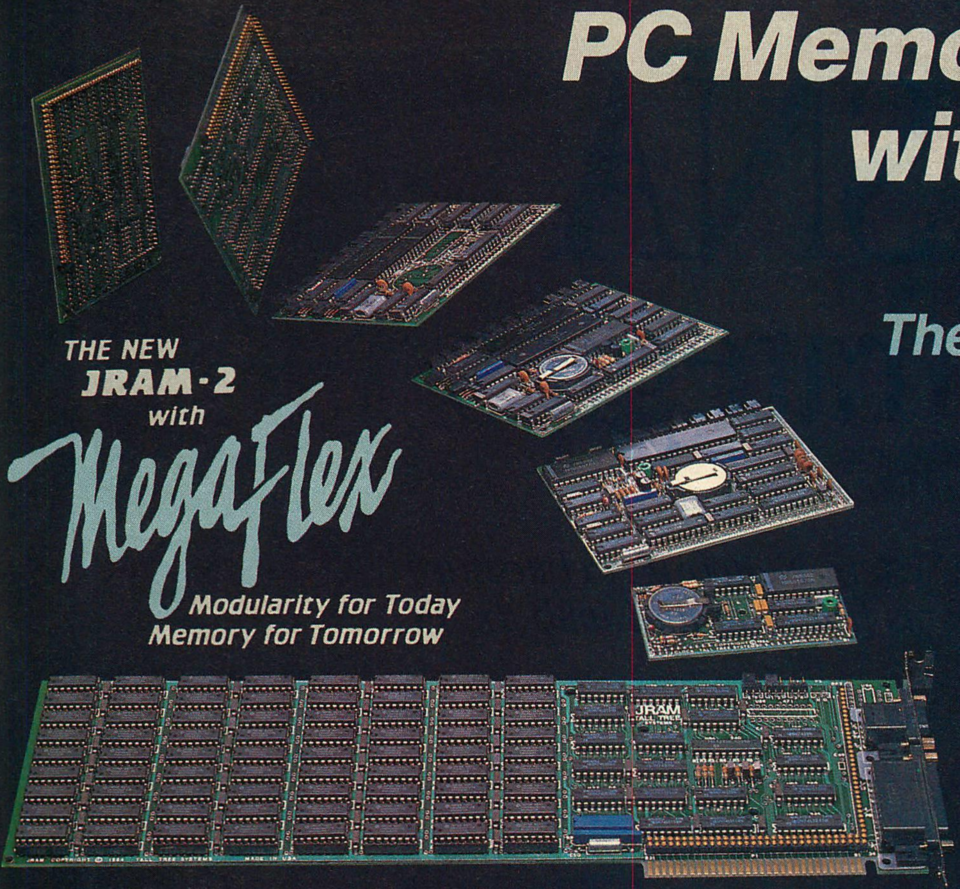

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TALL TREE SYSTEMS

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SNA Strategies

IBM's System Network Architecture realizes its full potential with the PC.

ART KRUMREY

How does the corporate data processing manager best handle linking one personal computer to another? His mainframes enjoy long-established links that operate at a very high speed. Passing disks back and forth (the traditional micro-to-micro link) is nearly impossible between micros and mainframes. Using asynchronous modems and tty dial-ups generally requires sophisticated software and considerable user training—frequently more trouble than they are worth. But what about using the powerful data communications infrastructure that lies between most IBM mainframes and their ubiquitous 327X terminals?

More than just a bunch of coaxial cables extending from terminal point to mainframe center, this infrastructure is a communications architecture with a surprisingly generalized and decentralized nature. Further, it is only with the PC's coming of age that this cable-and-controller infrastructure, better known as System Network Architecture (SNA), will realize its full potential.

IBM announced System Network Architecture in 1974. It was, in its early implementations, merely a generalization of earlier terminal-to-mainframe protocols. Today many organizations still use SNA in a strictly centralized way as a means of connecting terminals to one or more mainframes.

In SNA jargon, a *node* is a collection of users sharing the same path control structure into the SNA network. The most common example is a cluster of terminals connected by coaxial cable to an IBM 3274 or 3276 cluster controller. The controller parcels out data to the individual terminals connected to it, but from the controller onward into the network, the path structure is the same for all terminals in the node.

SNA considers a physical network of nodes connected by data lines to be a collection of *logical units* (LUs) connected by *sessions*. LUs can be terminals, printers, or, most recently, applications programs. Sessions are the logical connections between logical units and are quite independent of the physical nature of the connection.

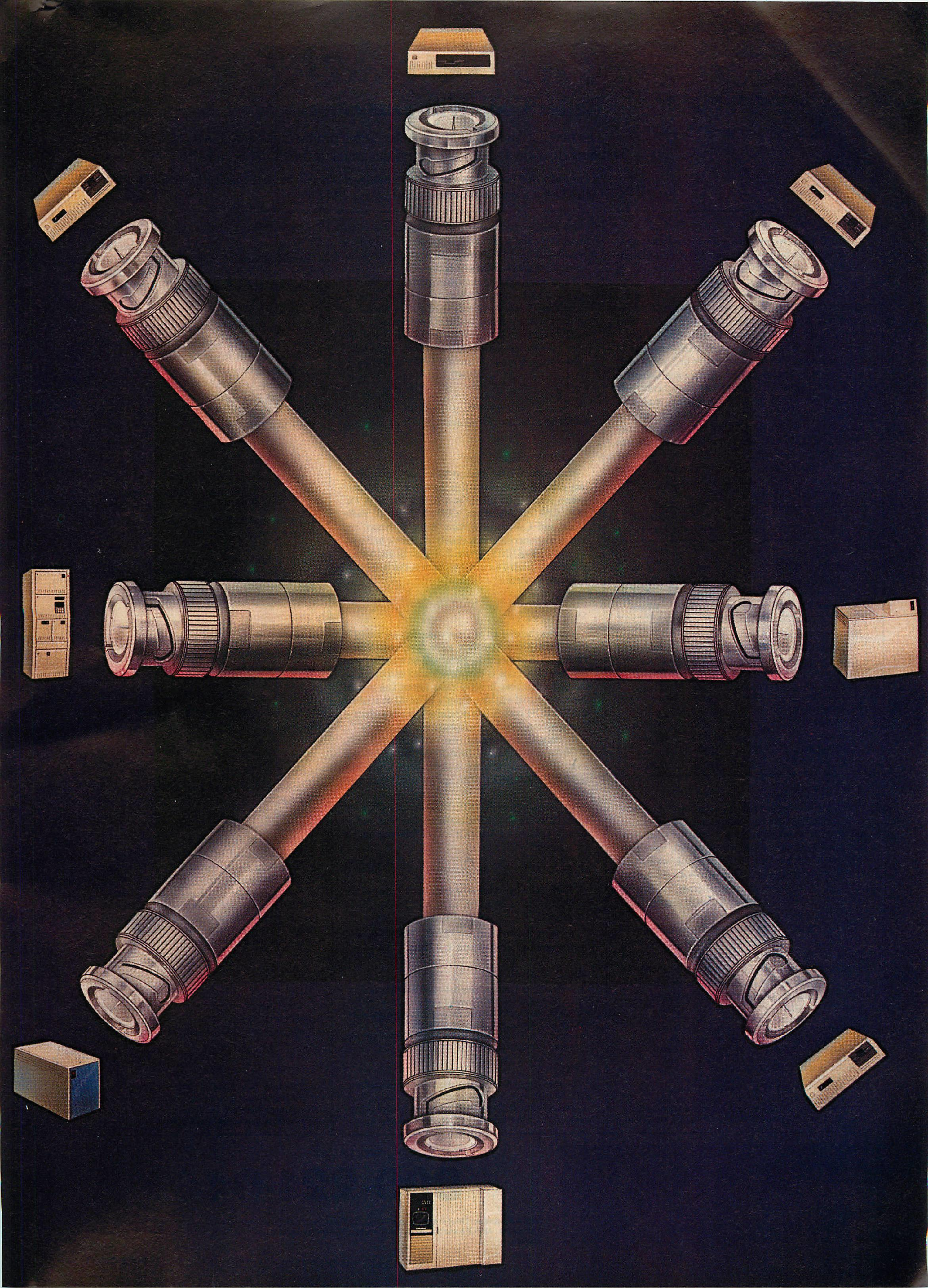
SEVEN LEVELS

This independence is made possible by SNA's layered structure. The seven levels of SNA correspond to the seven layers of the International Organization for Standardization (ISO) Reference Model for Open System Connection. The ISO layers and SNA's counterpart levels are shown in figure 1.

Level 1: Physical control. This is the physical interface between system components often called data terminal equipment (DTE) and data circuit terminating equipment (DCE). (A modem is the most obvious example of a DCE.) Level 1 defines the electrical characteristics and signaling necessary to make, maintain, and break the connection between the DCEs and DTEs. SNA uses the CCITT (International Consultive Committee for Telegraph and Telephone, headquartered in Geneva and part of the International Telecommunications Union.) V.24, or RS-232, standard most frequently in the U.S.; other CCITT interfaces, such as V.21 for public packet data networks, are also supported.

Level 2: Link control. Link control provides error-corrected transmission over a single data line between two nodes. SNA uses synchronous data link control (SDLC), which is a subset of ISO's high-level data link control (HDLC). SDLC is a bit-oriented protocol designed to be easy to implement, yet provide a low error rate over noisy circuits. SDLC's line control information always occurs

ILLUSTRATION • ANDY LEVINE



AZTEC

The New Aztec C

Better Code With Less Effort

The new 3.2 Version of Manx Aztec C86-c produces faster and smaller code with less effort than any C development system available for PC-DOS and MS-DOS.

"A compiler that has many strengths ... extensions seem to be quite valuable for serious work"
(Aztec C86 2.2 review in Computer Languages 2/85)

Better Code ...

Manx Aztec C86-c produces code that executes up to 60 percent faster in up to 60 percent less space than code produced by other PC-DOS and MS-DOS compilers. In short, it generates the best code available.

An extract from the C benchmark comparison in the January, 1985 issue of Computer Languages is reproduced here. Aztec C86-c clearly generated the best code. Modifying the sieve benchmark to use register variables presents an even clearer picture. Aztec C86-c executes in 6.51 seconds, Mark Williams executes in 7.56 seconds, and there is no improvement for Lattice and Computer Innovations Optimized C86. The Dhrystone benchmark results presented here are from a benchmark study conducted by MANX. The Dhrystone benchmark was published in the CACM (10/84 27:10 p1013) and converted by MANX from ADA to C. The Dhrystone benchmark was designed to produce a figure of merit for performance for systems software. For a full copy of the Manx Dhrystone and Whetstone benchmarks including timings for large memory models call Manx.

	Execution Time	Code Size	Compile/ Link Time
Sieve Benchmark			
Manx Aztec C86 2.2	11 secs	4,448	64 secs
Lattice 2.13	11 secs	21,902	98 secs
Mark Williams 2.0	12 secs	6,887	79 secs
Optimized C86 2.20G	13 secs	12,729	111 secs
Matrix Benchmark			
Manx Aztec C86 2.2	16 secs	7,804	92 secs
Lattice 2.13	29 secs	25,176	163 secs
Mark Williams 2.0	29 secs	10,847	107 secs
Optimized C86 2.20G	27 secs	13,766	134 secs
Dhrystone Benchmark			
Manx Aztec C86 2.2	36 secs	5,680	93 secs
Lattice 2.14	89 secs	20,404	117 secs
Mark Williams 2.0	56 secs	12,980	113 secs
Optimized C86 2.20J	53 secs	11,009	172 secs

... with Less Effort

At Manx, we understand the value of development tools, specialized features, professional documentation and technical support in making it easier for you to produce quality software. That's why we bundle more than $1000 worth of special features and tools with Manx Aztec C86-c, provide documentation that wins consistent praise for its clarity and completeness, and provide telephone access to experienced technical support for all Manx Aztec C products.

The following are some of the more important components of the Manx Aztec C86 Software Development System. Notice that many of the features that are bundled with Manx Aztec C86-c such as the debugger, Z editor, macro assembler, library source code, and ROM support are extra cost items with other systems.

Optimized C compiler	Symbolic Debugger
AS86 Macro Assembler	C Utility Library
LN86 Overlay Linker	DOS Function Library
Z (Vi) Source Editor-c	8087/80287 Sensing Lib
ROM Support Package-c	80186/80286 Support
Graphics Library	INTEL HEX Utility-c
CP/M-86 Library-c	Librarian
Screen Library	Graphics Library
Extensive UNIX Library	Object File Utilities
Library Source Code-c	Mixed memory models-c
Microsoft/Intel Object Option	Lattic, Microsoft, and CI-C86 Interface
Small and Large memory models	Unitools (MAKE, DIFF and GREP)-c

Manx offers two commercial development systems, Aztec C86-c and Aztec C86-d. Items marked -c above are provided as special features of the Aztec C86-c system. Other items are provided with both.

Third party software can often greatly improve software quality or significantly reduce software development time. Manx works with third party software developers to assure the availability of a wide variety of high quality third party software For Aztec C. Third party software is available directly from Manx. Some of the better known software products available for Aztec C86 are:

HALO	C WINDOWS	Amber Windows
PHACT	Sunscreen	PLINK86
C-TREE	PANEL	FirstTime
PRE-C	Greentree	C Util Lib

Call Manx to order or for information on third party software.

... and Portable, Too!

Manx Aztec C is the most portable C development system available. Manx Aztec C is the only C development system available for all of the following: MS-DOS, PC-DOS, CP/M-86, Macintosh, CPM-80, Apple II, Radio Shack and Commodore. Manx Aztec C syntax and library routines conform as closely as possible to the letter and spirit of UNIX Version 7, System III and System V. Software created for one environment can be adapted to a host of others.

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A wide variety of PC-DOS, MS-DOS, and CP/M-86, based cross compiliers are available. The host system must be licensed for Aztec C86-c. The following targets are available for $300 each:

Macintosh	Apple II	CP/M-80
TRS-80 III/IV	6502/6510/6511	8080/Z80

Call Manx for information on cross development to the 68000, 65816, Amiga, C64, C128, CP/M-68K, VRTX, and others.

For more information on XENIX, TOPVIEW and other specialized development, call Manx.

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Any Manx Aztec C86-c or Manx Aztec C86-d development system can be returned within 30 days for a refund if it fails to meet your needs. Restrictions are that the original purchase must be directly from Manx, and shipped within the USA. Returned items must be received by Manx within 30 days. A small restocking fee may be required.

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There are special discounts available to professors, students, and consultants. A discount is also available on a "trade in" basis for users of Lattice C, CI-C86, Mark Williams C, Wizard C, Digital Research C, and Microsoft C. Call Manx for details.

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To accommodate the widest possible audience of C users, Manx Aztec C is available in four configurations. Manx Aztec C86-c, Manx Aztec C86-d, Manx Aztec C86-p, and Manx Aztec C86-a.

Aztec C86-c (Commercial System) $499

This is the best C software development system available for PC-DOS, MS-DOS, and CP/M-86. It is heavily bundled with time saving development tools and special features (see list). Initial purchase entitles the licensed user to one year of computer tracked updates. After one year, the update service can be renewed on an annual basis for a modest fee.

Aztec C86-d (Developer's System) $299

This system includes all of the major elements of the Manx Aztec C86 Software Development System. Including Optimized C compiler, Macro Assembler, Linker, Librarian, Source Editor, and Symbolic Debugger. For price, performance, and professional features it is far superior to competing systems with list prices that are much higher. Aztec C86-d can be upgraded to Manx Aztec C86-c by paying the difference in list price plus $10.

Aztec C86-p (Personal System) $199

This system comes with a non-commercial license and can be upgraded.

Aztec C86-a (Apprentice System) $99

This system is designed to assist in learning the C language.

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Orders can also be mailed to Manx Software Systems, Box 55, Shrewsbury, NJ 07701.

There is no charge for standard domestic delivery. One day and two day express delivery is available to most areas for a minimal fee. Outside the USA standard delivery is $20 additional and express delivery is sent freight collect. Manx takes care of export documents and the like. COD on export is available to some areas.

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at the same place within a frame, and the line control information uses a different character set from the text. Thus, a character of text cannot accidentally be converted by noise to indicate a premature end of frame.

Level 3: Path control. Path control provides control from one user node to another across the network. This SNA layer incorporates two ISO layers: network and transport end-to-end control. Path control routes incoming packets to the appropriate outgoing data link control element (DLCE) or to the correct point within its own node. It also does packetizing of outgoing and depacketizing of incoming messages. Each node has only one path control function.

Level 4: Transmission control. This level establishes, maintains, and terminates logical connections for data transfer among end users or processes. Transmission control also enciphers data for security purposes, if necessary. There is one transmission control element (TCE) per session per user. Each TCE can be thought of as one end-user session's "front office" to the communications network. This distinction between session and user permits a PC connected by an SNA gateway to have multiple sessions, perhaps on different mainframes. Transmission control is part of ISO's session control layer.

Level 5: Data flow control. This level functions to accommodate the idiosyncrasies of message direction and intermittent frequency demanded by the end user. It correlates changes and organizes related data into indivisible units. Data flow is concerned with the user's need to communicate via either full or half duplex or whether the separate messages are parts of larger work units as seen by the end user or process. There is one data flow control function per session per end user. The ISO model combines SNA's levels 4 and 5 into its session control layer.

Level 6: Presentation services. This level defines the end user's port into the network in terms of code, format, and other attributes. Its job is to accommodate, for example, the totally different interfaces seen by a terminal in one node and what is expected by the applications program in the other node. Presentation services in SNA performs data compression, additions (such as column headings), and translations (program commands into local terminal commands, such as "clear screen"). Customer information control system (CICS) and information management system/data communications (IMS/DC) are two such presentation services in the IBM mainframe software world. (These other products also perform additional functions beyond presentation services.)

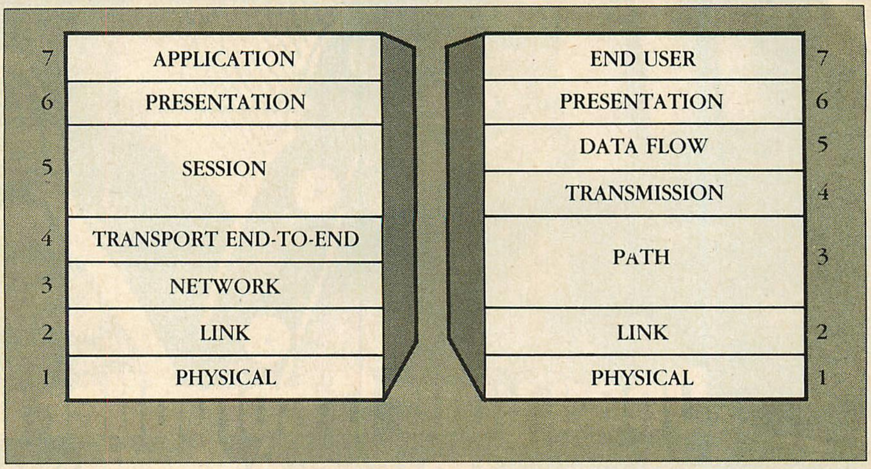
Level 7: The application. This is an SNA end user, a person (or process) who wants to use the SNA network. It may be internal or external to an SNA node. External end users may be PCs on an SNA gateway that are accessing a mainframe as a terminal or the mainframe applications program in use; internal end users may be applications programs, resident in an SNA node, that will transmit a PC user's file while the PC performs other functions.

SNA layers are more than mere taxonomy; they define peer interactions. For example, the transmission control layer need be concerned only about dealing with its peer, the transmission layer, at the other node, and with interacting with the layer above it in its node. It assumes that layers below it do their jobs to specification. Path control can assume that link control presents data to it correctly and need not be concerned about the algorithm used to transmit it without error.

Levels 1 through 3 are often called the transport layers because they are the most concerned with providing transmission services akin to a communications common carrier, such as a telephone operating company.

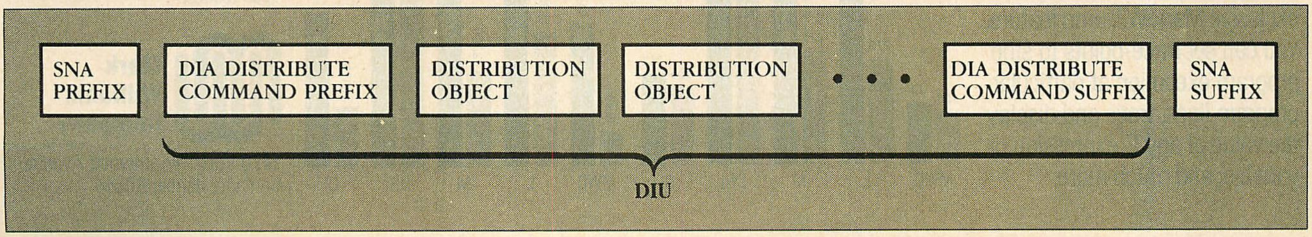
A node on an SNA network contains at least one LU and one PU (physical unit). The PU controls the resources of the node and responds to SNA commands, primarily from path and transmission control. It also responds to commands that are transmitted through the SNA network from the System Services Control Point (SSCP). There is at least one SSCP per network, with SSCP

FIGURE 1: *ISO Layers versus SNA Levels*



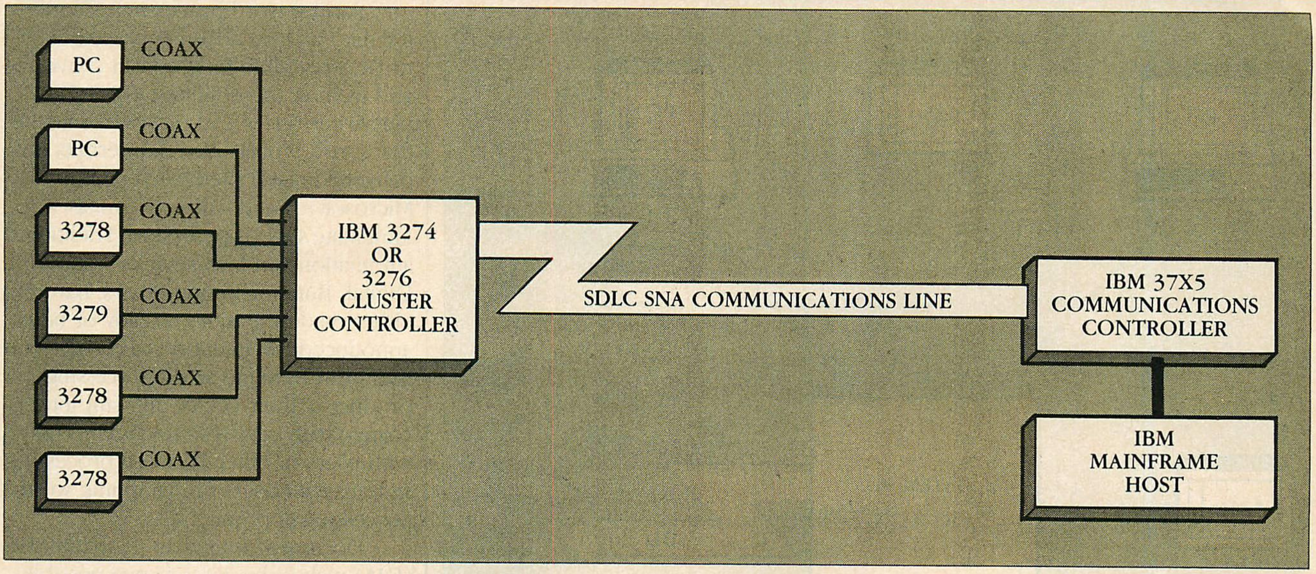
Correspondence between ISO layers and SNA layers is not 1 to 1. ISO layer 5 (session) encompasses SNA levels 4 and 5 (transmission and data flow). SNA level 3 (path) encompasses ISO layers 3 and 4 (network and transport end-to-end).

FIGURE 2: *Distribution Interchange Unit (DIU)*



The SNA prefix and suffix are further subdivided into layer-specific prefixes and suffixes. Note that the SNA prefix and suffix are *not* part of the DIU itself. The actual distribution of the DIU is accomplished by SNADS.

FIGURE 3: *PC to Mainframe SNA Connection through 3278/79 Emulation*



Popular 327X emulation products like DCA's IRMA series make a PC look identical to an IBM 327X terminal from the 3274/76 controller's point of view. The cost is very high if the controller and coaxial cables are not already in place.

commands typically coming from the mainframe host. The SSCP allows end users to access the network, activates links, and allows LU-to-LU sessions.

LOGICAL UNITS

An LU initiates a session with a partner by providing the partner's LU name. This LU name is transformed into an address placed into a packet header following access to a local or remote directory containing name-to-address translations. Actual execution-time routing uses the address carried in the packet headers. Each SNA layer typically adds a prefix and suffix to the basic packet sent by the application. These add-on prefixes and suffixes are shown in figure 2; they are presented to the peer layer of the remote node. Higher layers do not see the headers and trailers used by a given layer; lower layers transmit them as just more data.

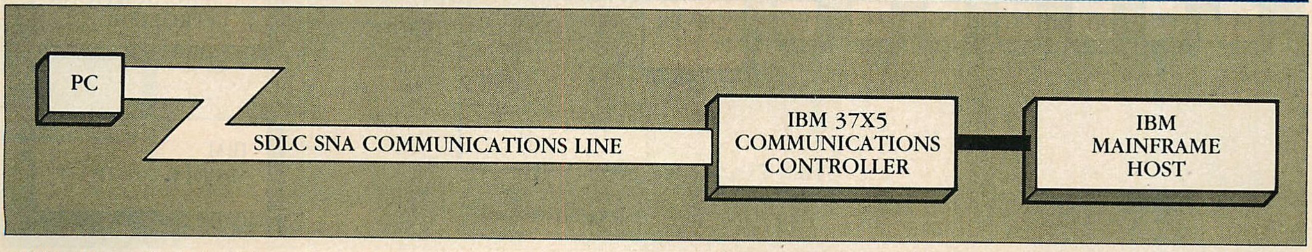
But what exactly are logical units? Presently they are terminals, printers, and processes. Processes are simply programs that use the network without the direct control of a human operator. Every logical unit performs only two functions: it activates a session, and it uses the session to communicate. The protocols with which it performs these two tasks are collectively called its *LU Session Type* (LU Type). The three groups of LU Types are as follows:

- LU 0: This is not specified by SNA. LU 0 is defined by particular implementations—for example, the Job Entry Subsystem (JES) of the Multiple Virtual Storage (MVS) operating system. When SNA sees an LU 0, it does not attempt to ensure compatibility between layers, but assumes that the LU knows what it is doing.
- Terminals
  LU 1: non-327X printers and other keyboard printers
  LU 2: 327X display terminals
  LU 3: 328X printers
  LU 4: like LU 1
  LU 7: 5250 display terminals, typically used on System/36 machines.
- LU 6: program to program. Release 2 of LU 6 is called advanced program-to-program communications (APPC).

Devices available today that connect PCs to SNA networks commonly allow the PCs to emulate LU 2s; some allow PC printers to behave like LU 3s. Figures 3 through 6 show four ways to connect a PC to an IBM mainframe through SNA. Currently, more than 35 vendors produce adapter boards or software for SNA access and 327X emulation. Such widespread support confirms the demand for this emulation.

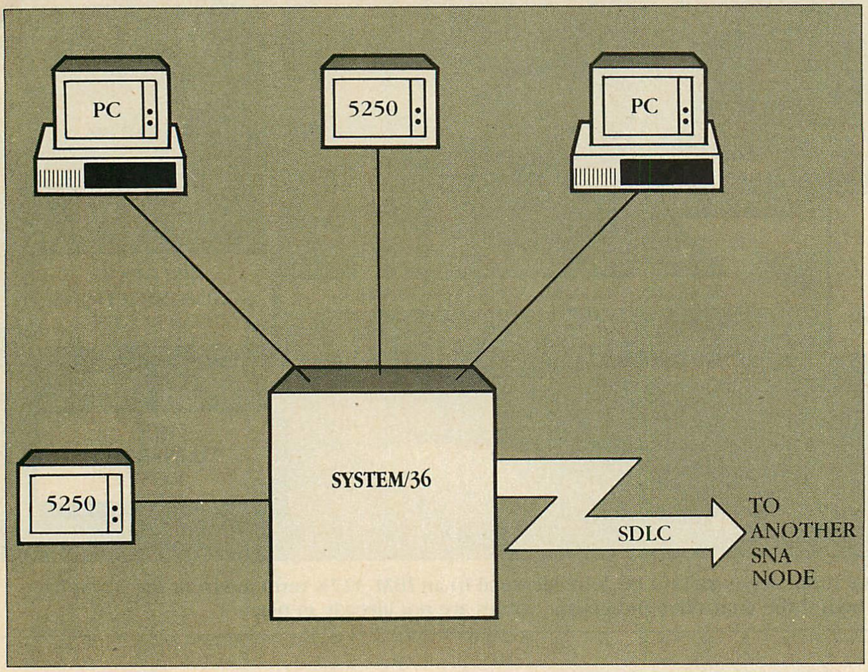
Terminal emulation, however, may be the tip of the iceberg where the user benefits of an SNA connection are concerned. SNA LU 6.2 can provide PC-to-PC file transfer without going through the mainframe at all. An understanding of how it works must begin with a discussion of IBM's Document Content Architecture (DCA) and Document Interchange Architecture (DIA), which are the cornerstones of IBM's office systems file transfer strategy.

FIGURE 4: *PC to Mainframe SNA Connection through SDLC Adapter on PC*



With this method, the PC emulates the 3274/76 cluster controller rather than a 327X terminal. Without additional workstations to share the cost of the modems and phone line, this method is often prohibitively expensive.

FIGURE 5: *PC Access to SNA through System/36*



The cabling between the workstations and the System/36 CPU is IBM proprietary.

DCA, DIA, APPC, SNADS, AND . . .
IBM's office systems communications strategy is summarized in this alphabet soup. Documents are composed at workstations and stored in a form defined by DCA. The document is placed into a logical envelope and addressed according to DIA. The document is then sent to another workstation via SNADS (System Network Architecture's Distribution Services) in response to a request by an applications program such as Personal Services/36 on a System/36. The owner of the originating document is free to work on another task.

The brains to perform this operation in an SNA node originate from LU 6.2 (remember, advanced program-to-program communication). SNADS is an application of APPC and resides in SNA layers 6 and 7 while APPC operates at layers 5 and below. The document interchange process is shown in figure 7.

DCA is a breath of fresh air in the atmosphere of incompatibility among word processing programs. IBM uses this format to transfer documents from its traditional Displaywriter Word Processor to its first entries in distributed office systems: the IBM 5520 and 8100.

The two types of DCA documents are revisable form text (RFTDCA) and final form text (FFTDCA). RFTDCA documents contain text and formatting specifications; their content and format can be modified. FFTDCA documents do not include formatting specifications; they are intended for print or display. Figure 8 illustrates the relationship between the two types of documents.

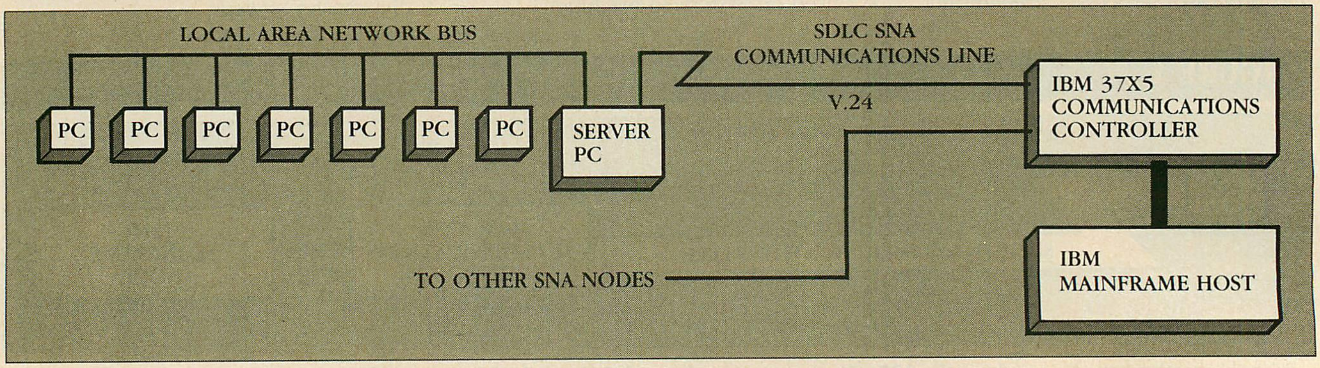
Several word processing programs for the PC store documents according to DCA revisable form or can convert to and from it; these include IBM's Displaywriter series and PCwriter. Satellite Software's WordPerfect 4.0 permits this conversion, and the next version of Microsoft's Word will conform, as will MultiMate's word processor. Traditional automation vendors, such as Wang, NBI, Digital, Burroughs, and others, have either made the move already or have announced the intention to do so. Soon users can have the word processing product of their choice and still interchange truly revisable documents both with users of other PC word processing systems *and* users of mainframe word processing applications.

Document Interchange Architecture (DIA) makes this interchange possible. It functions as more than the envelope in figure 7 would suggest—most envelopes do not transport letters that the recipient can change. And DIA will send the letter to multiple destinations and direct it to be archived in a library, perhaps on a mainframe host.

DIA's super-envelope concept is embodied as the distribution interchange unit (DIU). A DIU is any data object—a document is actually a special case—that contains a DIA distribute command in the form of a prefix and suffix bracketing the data. It is sent on its way by a distribution service program that runs in an SNA logical unit. An SNA LU running such a distribution program is called a distribution service unit (DSU). The distribution program that does this is SNADS.

SNADS is an advanced SNA presentation service, residing in layers 6 and 7 (see figure 1). Distribution requests are queued in presentation service and presented to the data flow and transmis-

FIGURE 6: *Typical PC to Mainframe SNA Connection through LAN*



Local PC-to-PC tasks are handled entirely by the LAN; SNA takes care of communications with mainframes and remote LANs.

sion control layers. The break from traditional terminal-to-mainframe traffic in the handling of LU 6.2 data, such as SNADS DIUs, takes place within layers 6 and 7. Terminals always establish sessions with other SNA logical units; by contrast, workstations using SNADS simply dispatch a document or other data. The difference is similar to that between establishing a phone conversion and sending a letter.

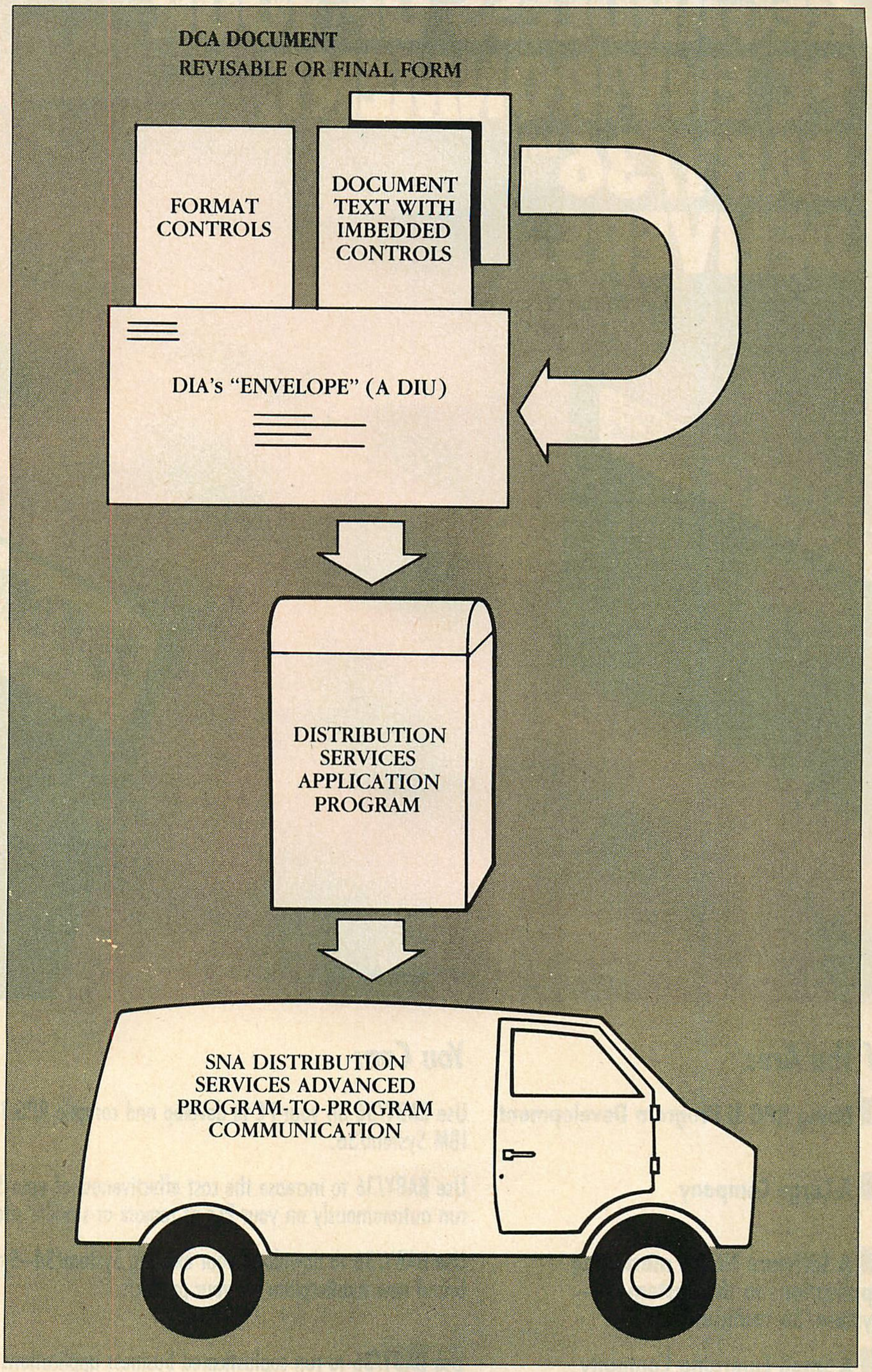
The distribution of data is then performed asynchronously—the originating task does not wait for its completion before continuing its function. (Do not confuse this use of asynchronous with its more familiar use in reference to start/stop terminals such as teletypewriters. Synchronous terminals wait for polling signals from their host; asynchronous, in a broader sense, refers to devices or processes that do not wait for a synchronizing signal.)

The transmission control layer's function for LU 6.2 also differs in that a DIU may be addressed to several DSUs, another LU (workstation queue) in the same node, and several remote LUs. In such a case, it must direct the DIU up to the local LU, and replicate it to path control to the remote DSUs.

A complete SNADS network is shown in figure 9. Users are named with distribution user names (DUN) and distribution service units are named with distribution service unit names (DSUN). A user's DSUN is his address; at any particular instant, a user has only one address. The DSUN can be split into two parts, to group users by location and further by function or department. In figure 9, A through E are DSUNs, and the common surnames in the boxes adjacent to the DSUNs are DUNs. DSUNs can be grouped by a distribution group name for ease of addressing. In the diagram, MAN and PER are group names; a user's DSUN can appear in several groups (as COLLINS appears in groups PER and PAY). An optional link to a mainframe running IBM's Distributed Office Support System (DISOSS) can archive documents and transfer them to other PCs that are connected to the mainframe.

Currently, only the IBM 5520, 8100, System/36 and System/38 office systems function completely as the DSUs just described. The 5520 and 8100 were the first distributed controllers in IBM's DISOSS architecture. System/36 SNADS support came later, and IBM is expected to announce a PC/AT enhancement that permits System/36 emulation. PCs connected as workstations to these office systems can use SNADS now. The

FIGURE 7: *Distribution of Document via SNADS*



Documents in either revisable or final form are sent in a DIU "envelope" and distributed by SNADS without further supervision by the originator of the document.

systems can automatically use the mainframe for archiving DCA documents or retrieving other mainframe information; the IBM mainframe program products DISOSS for MVS, and PROFS (Professional Office System) for VM will perform these functions.

What of the third-party SNA gateways, interfaces, and adapters advertised so pervasively? They will get the user to LU 2 and 3, some with multiple mainframe sessions. If the SNA interface has file transfer capabilities, a document can be sent through SNA to a mainframe, and from the mainframe it can be directed to another PC through SNADS. It is important to remember that LUs 2 and 3 *do not* have direct access to SNADS; that requires LU 6.2 support.

Four popular methods for hooking up a PC to today's SNA in an IBM environment are as follows (refer to figures

If You Are:	***You Can:***
Doing RPG II Program Development	Use BABY/36 on your PC to develop and compile RPG II programs that will run on your IBM PC, XT, AT or your IBM System/36.
A Large Company	Use BABY/36 to increase the cost effectiveness of your System/36, and use your existing application software to run autonomously on your PCs at remote or smaller sites.
A Software House marketing applications to the System/34–System/36 community	Use BABY/36 to download your existing System/34–System/36 applications onto the PC, thereby creating a brand new marketplace for your products.
A Small Emerging Company	Use BABY/36 to run sophisticated business applications software on the PC, and as you grow, this same software can be run on your System/36.
A Remote Location	Save thousands of dollars in communications costs by using BABY/36 with a PC, and transmit data only at the end of each day.
Troubled with an overloaded System/34 or System/36	Use BABY/36 on a PC to offload any of your applications, data files or development activities.
Networking PCs	Use BABY/36 . . . it understands IBM 3.1 Networking.
On a Restricted Budget	Use cost effective minicomputer software on cost effective personal computers.
INTERESTED!	Give us a call. (We also have BABY/34™ of course, which emulates IBM System/34 on the PC for all RPG II applications.)

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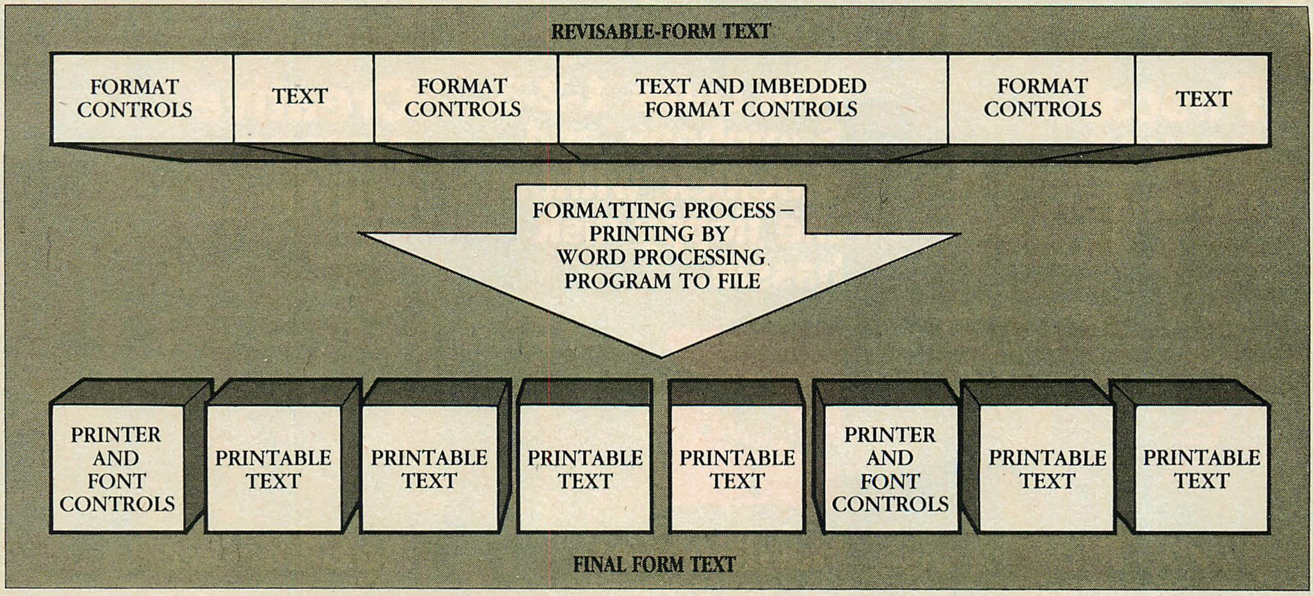
CIRCLE NO. 154 ON READER SERVICE CARD

FIGURE 8: *Relationship of Revisable-form Text to Final-form Text in DCA*



DCA revisable form text contains embedded format controls that can be changed. DCA final form text cannot be changed.

3 through 6, respectively):

1. Coaxial connection to an IBM 3274 or 3276 cluster controller
2. SDLC adapter connected to the SNA network
3. Connection to a System/36 or other office system
4. Connection to a LAN with a gateway to an SNA network

Using IBM hardware and software, the first method requires a 3278 Emulation Adapter ($905—all prices are IBM list) and the 3278/79 Control Program ($235). If coaxial access to a 3274 or 3276 controller is already present, cabling costs are kept to a minimum. This connection does not allow multiple mainframe sessions, but does have a file transfer capability. Access to SNADS is possible by transferring a DIA/DCA document to DISOSS on the mainframe and having DISOSS redirect it through the SNA network. Future direct access to SNADS is unlikely through the 3274/76 cluster controllers; the cluster controller function has been very tightly defined for some time, and IBM gives no indication of an expansion that would support SNADS.

In the second method, a PC emulates an IBM 3274/76 controller and requires an IBM SDLC adapter ($240) and the IBM SNA 3270 Emulation Program ($700). It also requires an RS-232 connection to a 37X5 controller, perhaps through modems and a leased telephone line. The 37X5 port costs between $2,000 and $4,000, depending upon the options included, and the modem/phone link costs several thousand dollars, plus ongoing operating expenses. These costs are divided among workstations in methods 1, 3, and 4; method 2 is usually the most expensive solution. Direct access to SNADS is not presently available (although documents can be transmitted through the host as described in method 1). It is feasible for an individual PC, but more likely an AT, to function as a DSU. PC networks are the most strategic place to introduce this capability, as discussed below. Many third-party vendors offer similar adapters and programs, sometimes at lower cost than IBM.

Micro Plus offers an interesting variation to method 2 with a master/slave hardware system. Its MP03 3274 controller board emulates a 3274/61 C controller and allows PCs equipped with the slave board and other LU 2 and 3 devices to be connected in multidrop fashion; as many as 128 LUs are supported. It is a LAN for mainframe service. The MP01 controller board lists for $1,695, the MP01 slave for $1,095; cabling is extra, so while this is not inexpensive, it may cost less than an IBM cluster controller.

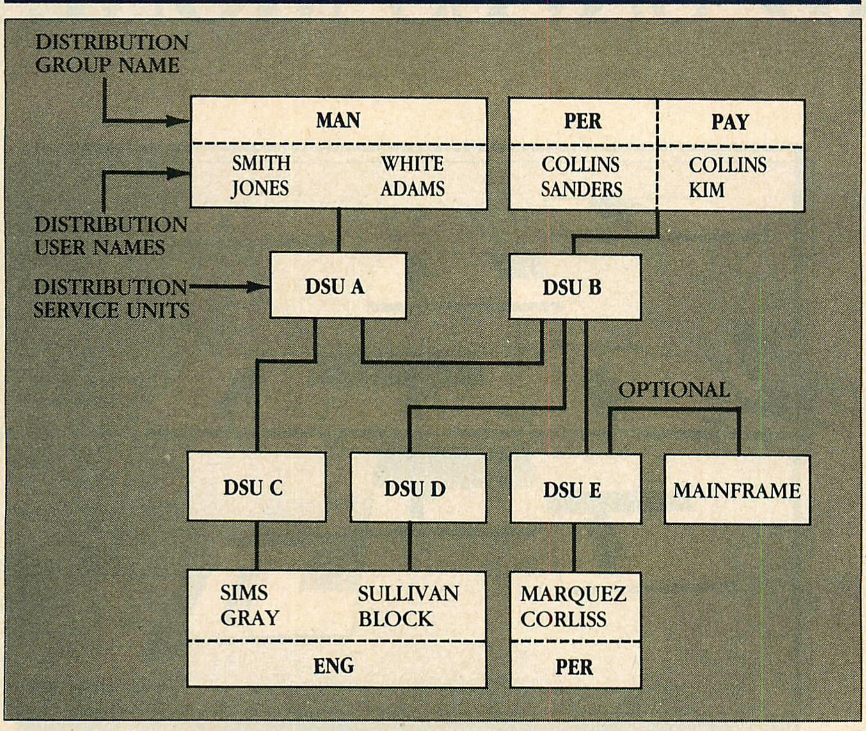
In methods 1 and 2, mainframe applications such as TSO, CMS, CICS, or PROFS provide presentation services. Data flow control is achieved by the virtual telecommunications access method (VTAM). VTAM, the presentation services program, and the application run on the mainframe. The function of lower layers transmission control through link control are performed by the network control program (NCP) in the 3725 or 3705 (37X5) communications controller; physical control is performed by 37X5 hardware.

The third method involves an office system processor such as the IBM System/36, 5520, 8100, or System/38. All of these system are currently offered, but IBM is clearly positioning the /36 as its strategic product in office systems. The typical System/36 configuration is much like a LAN with a star topology; the /36 is the central server. (See figure 5.) The system provides central file, print, and SNA communications services to PCs and can be used as a processor by dumb terminals.

IBM is promoting the PC as the principal workstation, and it announced the Personal Services and new Displaywrite products for System/36 in October 1984. Personal Services will provide PC users with mail, directory, and file cabinet services, and addressing documents under DIA for SNADS or DISOSS distribution. Displaywrite/3 for the PC and Displaywrite/36 for the System/36 provide their respective users with the same word processing environment. The System Support Program (SSP) includes support for LU 2 and LU 3 for 327X/328X emulation and LU 6.2 for SNADS. (Wang, NBI, Digital, Burroughs, and other vendors in the more traditional office market have announced similar products.) As with the /36, either PCs or dumb terminals can function as workstations.

The System/36 approach is cost effective only when enough workstations are connected sufficiently to distribute

FIGURE 9: *A Complete SNADS Network*



An SNA user's address is called a DSUN; at any one time a user may have only one address. Within the DSUN the user is identified by a Distribution User Name (DUN).

the costs of the central server. The typical configuration of an entry-level, 16-user system (minimally) consists of the equipment listed in table 1. Additional costs per PC connected to the system include $250 for the Personal Services/PC software and $845 for the System/36 Attachment Convenience Kit (cables, board, connectors). The cabling between the workstations and the System/36 is IBM proprietary: IBM must supply all of the hardware.

The cost of such a sophisticated central server can be justified by a large number of workstations or central applications. The /36 and other office processors have a rich set of applications programming languages and developed applications. In addition, they offer SNADS capability now for workstation-to-workstation file transfers.

Current rumors about a System/36 processor on a PC/AT suggest that these functions may be available soon on products that are classified as personal computers. Thus, methods 3 and 4 may become less distinguishable.

Method 4 is an access to SNA through a PC LAN. IBM's PC Network, Microsoft's MS-NET, and Novell's Netware are emerging as the software leaders. The PC Network Control program will, of course, run on IBM's PC LAN based on Sytek broadband hardware. Microsoft and Novell LAN software products run, or will run, on a variety of LAN hardware, including EtherNet, twisted pair, and (very likely) IBM's.

In the PC network, an SNA gateway requires a communications server—this is a PC, XT, or AT that may be used concurrently as a DOS workstation. This server must have an SDLC communications adapter. Table 2 shows a typical hardware/software configuration for a communications server that serves 16 workstations. Other expenses include a per-PC cost of $75 for the PC network software, $695 for the PC Network Adapter, and $375 for the PC Network SNA emulation program.

A communications server node incorporating the hardware and software in table 2 allows as many as 16 PCs on the IBM LAN to emulate a 327X. Each PC must have its own copy of the PC Network SNA emulation program. The server itself can be a workstation if fewer than 12 concurrent PCs are emulating 327Xs. The price is much more attractive than method 3, but LU 6.2 SNADS is not yet supported by any PC software (even though IBM appears poised for the move and other vendors are now building the support into their products).

Pathway Design has an SNA link/327X emulation package called netPATH for LANs running Novell's Netware. Netware is positioned to compete with Microsoft's and IBM's network software; it already runs on more than 10 PC LANs, including CORVUS, EtherNet, Gateway, Proteon, Santa Clara Systems, and, reportedly, the IBM LAN. It permits porting applications across the various hardware on which it runs.

Novell's LAN security is the best of the lot, with eight UNIX-like attributes for both users and files. It is the only LAN with a security system that distinguishes between program copy and execute, providing users the ability to execute a program, but not download it to disk (a pertinent consideration in light of recent lawsuits concerning violation of license agreements). Vendors are ever more frequently announcing versions of their software designed to be run on LANs; SSI's WordPerfect is a good example of such a product.

In addition, Novell has been shipping its products for more than a year; shipments of the IBM PC Network are just beginning. Netware includes electronic mail, disk caching, directory hashing, elevator seeking, and a full-screen help facility. Like any product that intends to survive the inevitable LAN shakeout, Novell's Netware is a true file server with record-level locks.

In mid-April, Pathway's netPATH was being shipped to beta test sites. It allows LU 2 and LU 3 emulation, with multiple sessions; as many as 32 communications sessions are supported concurrently. Pathway plans LU 6.2 support and is building support for it into the basic SNA layers. Later releases will provide LU 6.2 SNADS at the presentation layer and above. The company also plans an applications program to address a document using DIA and will have an alternative SDLC board with a coprocessor, allowing SDLC speeds of up to 56 kilobaud.

A Novell/Pathway communications server presently must be a dedicated PC. Table 3 shows a typical configuration for 16 PCs. The actual price is dependent upon the network hardware, the number of concurrent SNA sessions, and the number of Novell nodes (the prices quoted are for 16 workstations).

LAN SHAKEOUT

While the microcomputer industry seems to be settling down to a smaller number of established vendors and products, the field of LANs and micro-to-mainframe connectivity is still moving all too quickly in divergent directions. The Systems Network Architecture is complete, in place, and unlikely to need modification to support the future needs of connected microcomputers.

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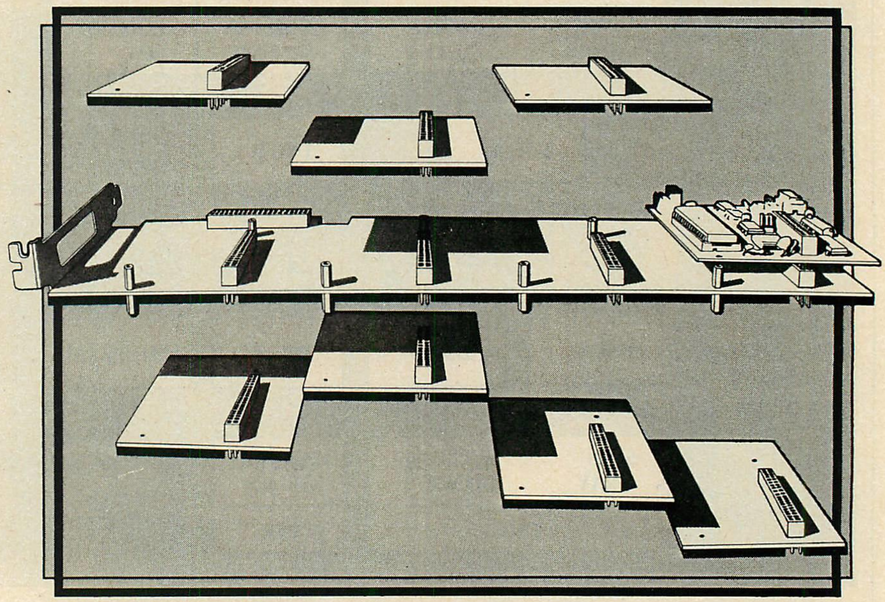

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SNA can be accepted as a given; the issue now becomes connecting to SNA—how and at what cost.

The cost of connecting several PCs to an existing SNA network is quite high unless much of the infrastructure (cabling, cluster controllers, high-speed phone lines, and modems) is already in place. The cost of building a LAN from scratch is much less and LANs promise to support access to SNADS through gateways—access that may never happen through the more limited portal of 3274/76 cluster controllers. IBM and Novell are clearly moving toward SNADS from their LANs.

The waters have not yet cleared around LANs. IBM's LAN is extremely new; not an in-house development, IBM bought the Sytek LAN technology for marketing, rather than technological, reasons. This broadband system uses a radio-frequency carrier that some experts say makes it less reliable than baseband (EtherNet-type) systems. Time will tell. MS-Net is not yet shipping, and there are still some holes in Novell's otherwise excellent product.

Waiting and watching LAN development could be the best course for the moment. Even though LAN technology is not yet mature, LANs do serve the microcomputer itself—and not simply as a sidekick to the mainframe. Novell has provided all the hooks for solving the knotty hassle of site licensing of software: a properly written application keeps track of the number of copies of itself that have been distributed to PCs on the network, and it locks out further use once the number equals that specified by a site license. (The application must do this housekeeping—the network provides only the hooks.) And, of course, as a *local* network, a LAN relieves the mainframe of handling strictly local matters, such as sending a copy of a large file to the PC in the next office.

It will take about a year for one of the three companies (IBM, Novell, or Microsoft) to establish itself as the dominant force in the LAN software arena. Networking software options should be held open until then. (Novell's LAN software currently runs under many vendors' hardware as will Microsoft's in the next year.) SNA is ready; programmers should study it and prepare to use its power as best suits their distributed computing needs.

TABLE 1: *Entry-level, 16-user System*

	PURCHASE PRICE	LICENSE/ MONTH
System/36 entry processor (128KB)	$18,000	n/a
System/36 options (512KB, communications, 22 workstations)	8,320	n/a
System/36 System Support Program	4,000	$235
SSP Feature 6003 for LU 2 emulation	2,500	none
Displaywrite/36	2,000	125
Personal Services/36	3,000	190
TOTAL	$37,820	$550

The costs for the System/36 processor often can be justified by considering the many applications software packages available for the System/36.

TABLE 2: *Communications Server for 16 Workstations*

	IBM LIST PRICE
IBM PC 5150 2 DSDD drives, 256KB	$2,295
IBM monochrome display	275
IBM monochrome display/printer adapter	250
SDLC communications adapter	240
2 PC Network translator units (each serves 8 PCs)	1,190
PC Network adapter	695
PC Network program	75
PC Network SNA emulation program	375
TOTAL	$5,395

This table lists costs for a 100-percent IBM LAN/SNA server system for 16 PCs. This system does *not* support LU 6.2 SNADS and IBM has not announced support for it.

TABLE 3: *Novell/Pathway Communications Server for 16 PCs*

	PRICE
IBM PC 5150 2 DSDD drives, 256KB	$2,295
IBM monochrome display	275
IBM monochrome display/printer adapter	250
Pathway communications adapter	295
Novell-compatible network adapter	695
Novell network starter kit	2,495
Pathway netPATH SNA-3270	1,395
TOTAL	$7,700

The Novell/Pathway SNA/LAN server system is slightly more expensive than an all-IBM system, but it has better security and will eventually support SNADS.

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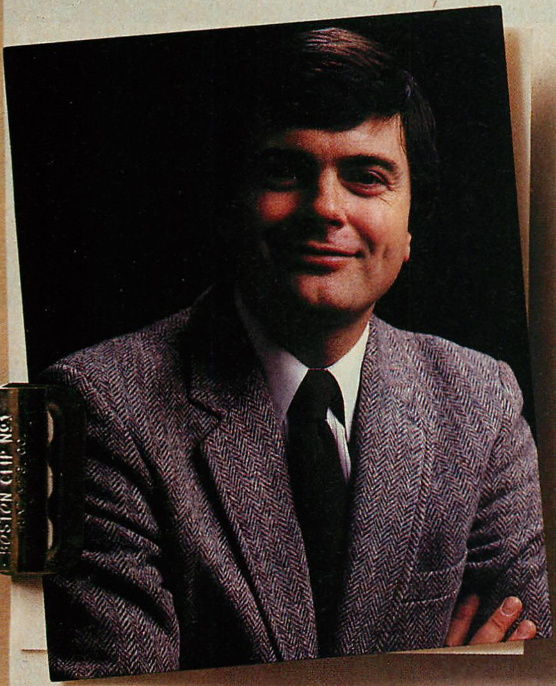
Art Krumrey is director of academic computing services at Loyola University of Chicago. He has a master's degree in computer science from Northwestern University.

His company has sent him on a mission to expand its IBM PC capabilities without bursting the DP budget.



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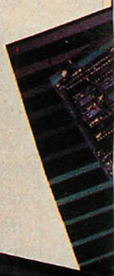

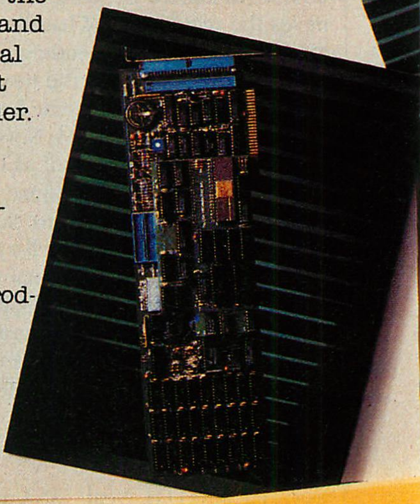

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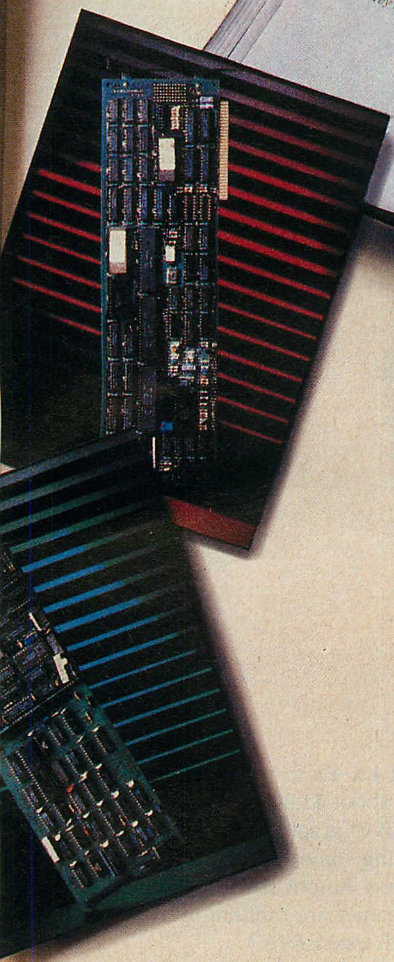

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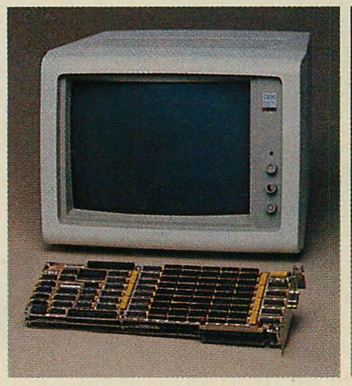
Power Graphics

The IBM Professional Graphics Controller and the Vectrix VX/PC



IBM Professional Graphics Display and PGC Board

Electrohome ECM 1301 RGB Monitor and Vectrix VX/PC Board

THOMAS V. HOFFMANN

PHOTOGRAPHS • CHRISTINE ARMSTRONG/BLAKESLEE LANE

With each new graphics card that is developed, the possibilities get bigger and better. Each new generation offers more colors, more resolution, more features, more fun. Over the past two years, *PC Tech Journal* has reviewed seven graphics cards; the next always seems to outshine the others. Such is the case with the eighth and ninth cards to be reviewed here: the IBM Professional Graphics Controller and the Vectrix VX/PC Color Card Set.

A little history may clarify the situation. The familiar IBM Color/Graphics Adapter (CGA) can display up to 4 colors at a time from a set of 16 colors in medium resolution (320 by 200), or black and a choice of one other color in high resolution (640 by 200). This product costs about $250. Big deal.

A few cards (such as Tecmar's Graphics Master) can provide all 16 colors in high resolution, and with the right monitor and a bit of programming magic, it can stretch the vertical resolution up to 400 lines. Priced in the $600 to $700 range. Better.

IBM's Enhanced Graphics Adapter (EGA) still gives only 16 colors in high resolution (640 by 350), but they are chosen from a set of 64 different colors: instead of just RGB and intensity, there are two bits for each color output, giving four intensities for each primary color, and 4 x 4 x 4 = 64 total. The EGA runs about $1,000 fully loaded with 256KB of graphics memory. Now we're getting somewhere. (Others must think so, too. Rumor has it that at least four companies are building EGA clones with extensions.)

The IBM Professional Graphics Controller (PGC) can display 256 different colors on the screen at the same time, choosing from a set of 4,096 po-

By varying the contents of the color look-up table, the digitized mandrill supplied on the PGC demonstration diskette can appear in many colors. These photographs were taken directly from the PGC screen.

tential colors (4 bits, 16 intensities per primary), in 640-by-480 high resolution. Cost is $2,995. This is serious stuff.

The Vectrix VX/PC does 512 colors at once, in 672-by-480 resolution, from the same set of 4,096 colors. Cost: $2,495. For $500 more the color set can be expanded to 16.8 million (8 bits, and thus, 256 intensities for each primary color). This is getting more and more serious all the time.

FEATURE THIS

These systems have a lot more to offer than just more pixels and colors. Both card sets (the PGC is a three-card sandwich; the VX/PC consists of two cards) contain on-board 8088-family processors that accept high-level commands from the host PC and independently perform the low-level pixel operations to form the displayed image. This greatly simplifies the programming required to generate images and relieves the host processor of the overhead of pixel-diddling. In addition, both products can emulate the original IBM Color/Graphics Adapter for compatibility with existing software.

Both high-level graphics command sets include functions for two- and three-dimensional drawing, color look-up table manipulation, and pixel-level image transfers in either direction. The 2-D commands include simple line drawing, arbitrary polygons, area filling, and text with variable size and orientations. The 3-D commands support translation, scaling, and rotation of 3-D objects, and perspective projection onto the 2-D screen. In addition, each product offers some unique features.

The PGC contains a simple but powerful command list that is very much like the macros common in assemblers, word processors, and many other applications. As many as 255 sequences of commands can be defined and then stored in local PGC memory—up to 20KB total. Any defined sequence can be executed one or more times with a single command. Command list executions can even be nested, like subroutine calls.

The VX/PC boasts a fast DMA image transfer capability (available only on the enhanced version with the 16.8-million color palette), and special image read-back commands that send the data in a form suitable for printing on 8-color printers. Two forms of hard-copy output are supported. One selects the printer color that most nearly approximates the actual displayed color for each pixel. The other form uses dithering techniques to produce 125 color combinations by mixing the three primary colors in groups of four pixels. Utility programs are provided to transfer images from the VX/PC to the Radio Shack CGP-220 Color Inkjet, Canon Inkjet, and Quadram Quadjet printers. Other features supported by the VX/PC include a light pen, crosshair graphics cursor, and hardware pan and zoom.

The PGC contains a simple but powerful command list feature that is very much like the macros common in assemblers, word processors, and other applications.

Table 1 is a side-by-side comparison of the features of both systems.

HARDWARE ARCHITECTURE

The PGC is a three-board sandwich. One outer card contains 320KB of graphics memory and associated logic; the other has an 8-mHz 8088 processor with 64KB of ROM; and sandwiched between them is a shorter card with the CGA emulation support logic. The two outer cards are spaced 0.8 inches apart to fit into two adjacent expansion slots in an PC, XT, or AT expansion chassis. The PGC will not fit in a standard five-slot PC motherboard because the slots are too far apart. This is a distinct disadvantage to owners of five-slot PCs. If IBM had used a flexible cable between the boards, as Vectrix does, then any PC could accept the unit.

The display and memory logic on the PGC is designed for very fast access by the display microprocessor: memory is fetched 20 bytes at a time from five 32-bit-wide banks, and special latches buffer data written to the display memory, allowing the PGC's 8088 to run at full speed even during display refresh.

All PGC commands, even the lowest level 2-D line drawing and area filling commands, are implemented in software that is contained in the 64KB ROM program executed by the on-board 8088 processor. Apart from the clever display memory organization mentioned earlier, the PGC has no special graphics hardware. Unlike the Enhanced Graphics Adapter, the PGC uses very few custom, large-scale integrated (LSI) circuits, apart from some programmable logic arrays that are used to control the addressing sequence of the graphics memory.

The PGC's color look-up table contains 256 12-bit entries, consisting of 4 bits of intensity information for each of the three primary colors: red, green, and blue. Since each primary can have 16 intensities, a total of 16 x 16 x 16, or 4,096, colors is possible.

The VX/PC has only two boards, with a ribbon cable connecting them to each other. In the 16.8-million color version, a small daughterboard is added to one card. Since the board spacing is not fixed (as it is in the PGC), either version of the VX/PC will fit in two adjacent slots in any IBM PC and many compatibles. The Vectrix set uses an 8-mHz Intel 80188 processor and an NEC 7220 single-chip graphics processor.

The NEC 7220 manages the graphics memory and CRT timing and has built-in capabilities for 2-D drawing, area filling, character generation, light-pen debouncing, and panning and zooming the image. The 7220 reduces the complexity and cost of a graphics display system, but imposes some performance penalties as implemented in the VX/PC. It has a single 16-bit data path to the display memory, as compared to the PGC's 160-bit-wide path; the difference is quite noticeable in memory-intensive operations such as area filling. The VX/PC's performance in simple 2-D drawing functions is inversely proportional to the number of bit planes enabled; the PGC is much less influenced by bit plane masking.

The VX/PC color look-up table has 512 entries, each of which has eight bits for each primary color. In the basic card set only the high-order four bits of the color table entries are actually used, resulting in the same 4,096 potential color combinations as the PGC. In the expanded 16.8-million color palette version, the low-order four bits in each entry are active, providing 256 possible intensities per primary color.

Both the PGC and the VX/PC require high-resolution analog displays, such as the IBM Professional Graphics Display ($1,295). This display has a 14-inch monitor with a .31mm-dot pitch black matrix screen and a special contrast-enhancing, anti-reflective screen coating. The Professional Display operates at a 30-kHz horizontal scan rate, noninterlaced, with a refresh rate of 60 frames per second, and can display 640 pixels by 480 lines. The video bandwidth is 25 mHz.

Notice, however, that the Professional Graphics Display is the same size

TABLE 1: *Feature Comparison*

	PGC	VX/PC
PHYSICAL		
Backplane spacing requirement	8 inches only	Any PC
Slots required	2 full size	2 full size
Power (5 volts DC)	5.0 amps	4.5 amps
DISPLAY PROCESSOR		
Processor	8088, 8 mHz	80188, 8 mHz
Processor firmware	64KB	16KB (32KB max)
Processor RAM	20KB	8KB
User programmable	No	Yes
Graphics Processor	Discrete logic	NEC 7220
Graphics Memory	307KB	384KB
DISPLAYED IMAGE		
Resolution	640 by 480	672 by 480
Bit planes/colors	8/256	9/512
Palette (total colors)	4,096	4,096 standard 16.8 million optional
CONFIGURATION		
Coexist with monochrome	Yes	Yes
Coexist with CGA	Yes	No
CGA emulation mode	Yes	Yes
Emulation performance	Slow (text)	Normal
Emulation character box	8 by 16	8 by 8
PROGRAMMING CONSIDERATIONS		
Communications scheme	Memory FIFO	I/O, DMA
Virtual coordinates	−32768.00000 +32767.99999	−32768 +32767
Accepts floating point	Yes	No
2-D drawing	Yes	Yes
3-D drawing	Yes	Yes
2-D transformations	Yes	Viewport only
3-D transformations	Yes	Yes
2-D clipping	Yes	Yes
3-D clipping	Yes	Limited
Drawing modes	Replace Complement	Replace Complement OR
Bit plane masking	Yes	Yes
Relative drawing	Yes	Yes
Line patterns	16 by 1	16 by 1
Polygon fill	Yes	Yes
Polygon fill pattern	8 by 1	16 by 1
Area fill (paint)	Yes	Yes
Area fill pattern	16 by 16	No
Text, variable sizes	Yes	Yes
User-defined fonts	Yes	Yes
MISCELLANEOUS FEATURES		
Display lists	Yes	No
Graphics cursor	No	Yes
Pan/zoom existing image	No	Yes
Light-pen support	No	Yes
Color printer support	No	Yes
SUPPORT		
Documentation included	Installation, VDI driver	Installation, programming reference
Software included	VDI driver (object only), diagnostics	DOS driver (source included), displays, color printer support

Overall, IBM's PGC seems to offer more than the Vectrix VX/PC, but each of these impressive products has unique features in its favor.

and shape as the other IBM PC displays and uses the same nine-pin signal plug, but its scanning frequency and pin configurations are quite different from, and incompatible with, other PC displays. It should not be plugged into any adapter other than the PGC.

The look-alike, plug-alike feature makes for familiar and attractive styling, but an office using a mixture of systems and displays could be susceptible to some expensive mistakes. A distinct plug would be a simple and effective means for avoiding confusion and possible equipment damage.

Vectrix offers the Electrohome ECM 1301 RGB Monitor (also $1,295) for use with the VX/PC card set. The ECM 1301 is a 13-inch monitor with .31-mm pitch, operating at a maximum of 25.5-kHz horizontal scanning frequency with a video bandwidth of 25 mHz. The VX/PC displays 672 pixels on each scan line, but operates in interlaced mode at the rate of 84 fields or 42 full frames per second. The slower frame rate is not objectionable by itself, but the interlaced operation results in highly visible raster scan lines, much like those on a standard television. The IBM display shows no such effect; its image quality is superior. Vectrix says it will offer a $200 option that will improve the display appearance and minimize the scan line visibility.

The Electrohome is a hefty (52 pounds) industrial-quality display monitor, with independent BNC connectors for red, green, blue, horizontal sync, vertical sync, and ground. A switch on the rear panel provides a selection of horizontal scan frequency ranges, allowing it to be used at standard TV rates (15 kHz), 350-line high resolution (18 kHz), or 480-line resolution (25 kHz).

In a world full of televisions and displays of Oriental origin, it is interesting to note the Electrohome monitor is manufactured in Canada and the IBM display is made in Finland.

AVAILABLE APPLICATIONS

The IBM PGC and companion Professional Graphics Display were announced in September 1984 and have been available since early this year. A number of companies are working on applications to support the system. Although more than a handful of companies are working on software, *PC Tech Journal* was unable to obtain any packages, even in test versions, in time for this review.

The VX/PC has been around for a longer time, marketed primarily to OEMs and systems houses. A variety of

applications packages support the Vectrix card set; one of the best known probably is AutoCad from AutoDesk of Sausalito, California, which also runs on many other cards, including the original IBM CGA and the Tecmar Graphics Master. Other programs for applications from graphic arts to engineering drawing and even TV weather map displays are available for the VX/PC from Vectrix and other vendors.

The PGC comes with a vast array of installation instructions, a new diagnostics diskette and replacement pages for the *Guide to Operations* (for the AT, XT, or PC with expansion chassis), and a diskette containing the low-level, PGC-specific Virtual Device Interface (VDI) driver. Of course, without an applications or development program that comes with the high-level VDI.SYS driver and uses the VDI, the PGC is merely a very expensive CGA emulator.

Programming and technical information for the PGC is supposed to be available as part of the multivolume *Options and Adapters Technical Reference* (OATR). Unfortunately, obtaining this document is a little more complicated than just buying it at the local IBM dealership. The OATR is a "living" manual, with updates continually issued for new products, and the PGC is too new yet to be included in the manual. Therefore, the user first has to buy the manual set for $125, return the update request card, then wait patiently for the letter carrier. *PC Tech Journal* bought the document in question and returned the update form long ago; to date, we have received no updates of any kind.

IBM should include the technical reference information with its product. A high-powered, sophisticated $3,000 product such as the PGC deserves instructions at a higher level than those for a $29 electric fan: plug it in, keep your fingers out of it, and stay cool. The extra cost of a user manual, relative to the price, is certainly small, and IBM surely can afford it.

As the flagship product in the Engineering and Scientific family, the PGC obviously is intended for sophisticated users, many, if not most, of whom will want to do their own programming. The PGC is very easy to program, and the technical reference material from IBM is typically terse, but complete and easy to understand.

Vectrix has the right idea about documentation and product support. First of all, a fat user manual comes in the same box with the two skinny PC cards. Better still, the manual starts off with an explanation of the system's features and functions, complete with many programming examples in BASIC.

In addition to the manual, Vectrix supplies a diskette with a DOS device driver (which runs with DOS 2.0 or later) in both source and object form, making it very easy to talk to the board in ASCII from BASIC or any other language that supports DOS file access. The program diskette also includes some utilities for capturing and printing images on various color printers, fast DMA image transfer programs, and some sample assembly language routines for accessing the board directly.

Programs for applications from graphic arts to engineering drawing and TV weather map displays are available for the VX/PC.

Available separately from Vectrix for $45 is the *Advanced Programming Manual*, which provides information about how to write code that can be sent to the VX/PC for execution in its 80188 processor. Such code has full access to the NEC 7220 as well as the subroutines in the VX/PC on-board ROM. This manual conveys a good attitude on the part of Vectrix, even inviting phone calls from those in need: "We always have engineers around to help."

If Vectrix can provide complete information for technical users and invite its customers to call for help, then the biggest computer company of all should be able to offer a similar service at least for its high-end products. A simple IBM registration card included with the product could be returned to activate the user's call-in privileges. This process also would avoid a flood of calls from unauthorized persons.

CGA EMULATION

Both the PGC and the VX/PC card sets have the capability to emulate the functions of the original IBM Color/Graphics Adapter. The hardware actually appears to the host processor as a fully functional CGA. Neither card set has any special BIOS enhancements to support the CGA mode; none is required. The standard PC BIOS cannot tell the difference. (The Vectrix DOS device driver does contain some code that replaces the BIOS character output routines. Vectrix says this code fixes a bug in the original BIOS that causes snowy interference during scrolling.)

The PGC emulates the original CGA primarily by software in the display microprocessor, with some hardware to recognize the I/O register addresses corresponding to the CGA hardware registers. In emulating the CGA text modes, the PGC uses a high-quality, 16-by-8-pixel character block in place of the CGA 8-by-8 block, resulting in a much more readable display. Unfortunately, the high-quality text mode is about three times slower than the CGA in 80-column text mode. In graphics modes (such as those set by BASIC's SCREEN 1 or 2 commands), text characters formed by BIOS from its internal tables will still have an 8-by-8 format.

The Vectrix CGA emulation is hardware-based and operates at essentially the same speed as the CGA in all modes. Character mode uses the same 8-by-8 blocks as the CGA. The PGC's high-quality, 16-by-8 character font is far superior in appearance.

The PGC can coexist with a CGA in the same system. A jumper is provided to disable the emulator function, allowing a real CGA to be used. The VX/PC, however, cannot be used in the same system with another CGA or compatible card. Either card set can be used with an IBM monochrome adapter.

Both systems support software commands for switching between emulation mode and high function mode. IBM maintains two independent display buffers and updates each one regardless of which is actually being displayed on the monitor. The VX/PC also maintains two images, but commands that would affect the image that is invisible are ignored. This situation is quite annoying if the VX/PC is the only display adapter in the system, requiring explicit mode switching before any data can be sent to the standard console.

Although either system can function as the only display on a PC, a monochrome adapter and display would be a valuable addition to any system that supports word processing, spreadsheeting, or other text-intensive activities. The PGC's slow performance in text mode, and the VX/PC's blocky text image quality (no worse than the CGA, of course, but no better either) make them poor choices for general-purpose text applications. The extra $400 or $500 spent for an additional monochrome display system is well worth it.

Neither emulator supports programmable border colors; the screen border is always black.

TABLE 2: *PGC Command Summary*

2-D DRAWING / 3-D DRAWING

2-D code	2-D short	2-D long	3-D code	3-D short	3-D long
3C	AR	ARC			
38	CI	CIRCLE			
28	D	DRAW	24	D3	DRAW3
29	DR	DRAWR	2B	DR3	DRAWR3
39	EL	ELIPSE			
10	M	MOVE	12	M3	MOVE3
11	MR	MOVER	13	MR3	MOVER3
08	PT	POINT	09	PT3	POINT3
30	P	POLY	32	P3	POLY3
31	PR	POLYR	33	PR3	POLYR3
34	R	RECT			
35	RR	RECTR			
3D	S	SECTOR			

3-D MODELING TRANSFORMATIONS

52	MRD	MATXRD	Read modeling or viewing matrix
90	MDI	MDIDEN	Set modeling matrix to Identity
97	MDM	MDMATX	Set complete modeling matrix
91	MDO	MDORG	Set modeling origin
93	MDX	MDROTX	Rotate model about *X*-axis
94	MDY	MDROTY	Rotate model about *Y*-axis
95	MDZ	MDROTZ	Rotate model about *Z*-axis
92	MDS	MDSCAL	Scale model (sx,sy,sz)
96	MDT	MDTRAN	Translate model (tx,ty,tz)

3-D VIEW/WINDOW/PROJECTION

AA	CH	CLIPH	Clip hither
AB	CY	CLIPY	Clip yon
AF	CV	CONVRT	Convert current 3D point to 2D current point
B1	DS	DISTAN	Specify distance from eye to VRP
A8	DH	DISTH	Specify hither plane distance from VRP
A9	DY	DISTY	Specify yon plane distance from VRP
B0	PRO	PROJCT	Specify angle of view for perspective projection
A0	VWI	VWIDEN	Set viewing matrix to Identity
A7	VWM	VWMATX	Set complete viewing matrix
B2	VWP	VWPORT	Define viewport on screen coordinate space
A3	VWX	VWROTX	Rotate eye about *X*-axis of VRP
A4	VWY	VWROTY	Rotate eye about *Y*-axis of VRP
A5	VWZ	VWROTZ	Rotate eye about *Z*-axis of VRP
A1	VWR	VWRPT	Set viewing reference point (VRP)
B3	WI	WINDOW	Define corners of window in 2D virtual space

**The CA and CX commands (set ASCII or hex communications mode) have no special hexadecimal code; their ASCII form (followed by a blank—hex 20) is recognized in either mode.*

COMMAND LISTS

70	CB	CLBEG	Comand list begin<cl number>
74	CD	CLDEL	Command list delete <cl number>
71	CE	CLEND	Command list end
73	CL	CLOOP	Command list loop <cl number> <count>
75	CRD	CLRD	Command list read <cl number>
72	CR	CLRUN	Command list run <cl number>

MODE SET/READ

*—	CA	CA	Communications ASCII
*—	CX	CX	Communications hexadecimal
D0	DI	DISPLA	Display (0=high function, 1=CGA emulation)
51	FRD	FLAGRD	Flag read <flag number>
04	RF	RESETF	Reset flags
05	W	WAIT	Delay specified number of frames (1/60 sec)

COLOR FILLS/PATTERNS

C0	A	AREA	Area fill
C1	AB	AREABC	Area fill to boundary color
E7	AP	AREAPT	Area pattern
0F	CLS	CLEARS	Clear screen to color (ignores mask)
06	C	COLOR	Set drawing color
07	F	FLOOD	Clear viewport to specified color
EF	FM	FILMSK	Set fill mask
EB	LF	LINFUN	Line function
EA	LP	LINPAT	Line pattern
E8	MK	MASK	Set bit plane mask
E9	PF	PRMFIL	Primitive fill flag

IMAGE TRANSMISSION

D8	IR	IMAGER	Image read
D9	IW	IMAGEW	Image write

LOOK-UP TABLE OPERATIONS

EE	L	LUT	Set LUT entry <index> <r> <g> <b>
EC	LI	LUTINIT	Initialze LUT
50	LRD	LUTRD	LUT read entry <index>
ED	LS	LUTSAV	LUT save

TEXT

82	TA	TANGLE	Text angle
84	TD	TDEFIN	Define text character set
80	T	TEXT	Text (uses built-in characters)
83	TP	TEXTP	Text programmed (uses defined characters)
85	TJ	TJUST	Text justify
81	TS	TSIZE	Text size

For each PGC command, the one-byte hexadecimal code used in hex mode is shown, followed by the short and long command names, either of which may be used in ASCII mode. The PGC accepts upper- or lowercase letters in ASCII mode.

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CIRCLE NO. 217 ON READER SERVICE CARD

The PGC supports a more complete and logically consistent set of high-level graphics functions than the VX/PC. This means that in order to get the same results, the VX/PC requires more work in some cases. Table 2 summarizes the PGC command set, and table 3 lists the Vectrix commands.

WINDOWS AND VIEWPORTS

In the PGC, two-dimensional drawing commands operate on a virtual coordinate space ranging from −32768.00000 to +32767.99999 in *X* and *Y* dimensions. A *window* on the 2-D virtual space defines the limits of the visible area; any part of an object that falls outside of the window that is in effect when it is drawn will be clipped at the window boundary.

A *viewport* defines a rectangular area of the screen that completely contains the defined window, and thus the mapping from 2-D virtual coordinates to the absolute screen coordinates. The PGC screen coordinates range from (0,0) at the lower left corner to (639,479) at the upper right.

The screen aspect ratio of 4 to 3 (640 to 480) is the same as a standard movie frame. Unlike previous IBM displays, the pixels are the same size both vertically and horizontally. This means that a rectangle that has 50 screen units on a side will actually appear to be square. If the window and viewport are defined with the same aspect ratio, then the proportions of the displayed image will match those of the virtual image. If the proportions do not match, then the image will appear to be either stretched or compressed.

Two-dimensional drawing commands let the user move about the virtual coordinate space; draw lines, rectangles, polygons, circles, arcs, sectors, and ellipses; and specify the colors and fill patterns to be used in drawing the various objects. Text is also a 2-D phenomenon and can be drawn in various sizes and orientations.

The PGC deals with 3-D objects in a virtual coordinate space ranging from −32768.00000 to +32767.99999 in *X, Y,* and *Z* dimensions. Three-dimensional drawing commands let the user move around the 3-D virtual space to an absolute coordinate or relative to the current point, and draw points, lines, or polygons in any color.

Figures that are drawn in 3-D space undergo several transformations on their way to the 2-D screen. The *modeling transform* specifies scaling, rotation, and translation of figures in the 3-D virtual space. The *viewing transform* specifies the orientation of the viewer with respect to any chosen point in the virtual 3-D space called the *viewing reference point* (VRP).

TABLE 3: *VX/PC Command Summary*

$	Display text	**RC**	Replace complement mode for pixel writes
A	Arc or circle	**RD**	Return drawing point
B	Bitplane write mask	**RE**	Replace mode for pixel writes
C	Set color	**RF**	Rectangle fill
D	Dot	**RL**	Return light-pen position
E	Erase screen	**RNP**	Read encoded pixels
F	Filled convex polygon	**RNR**	Read encoded graphics RAM
G	Go warmstart	**RP**	Read pixels
G0	Go coldstart	**RQ**	Return color look-up table value
HNP	Hardcopy nondithered print	**RR**	Read graphics RAM
HNR	Hardcopy nondithered reverse print	**RV**	Return version number
HP	Hard-copy dithered print	**SX**	Scale in *X* direction
HR	Hard-copy dithered reverse print	**SY**	Scale in *Y* direction
HX	Select hex mode	**SZ**	Scale in *Z* direction
I	Initialize transform matrix	**SI**	Select IBM CGA emulation mode
JA	Adjust character angle	**SV**	Select Vectrix high function mode
JD	Design new character	**SP**	Set perspective scale
JM	Change character magnification	**SQ**	Set LUT to default values
JN	Display default character set	**TX**	Translate in *X* direction
JR	Set rectangular fill pattern	**TY**	Translate in *Y* direction
JS	Set character spacing	**TZ**	Translate in *Z* direction
K2	Select 2D coordinates	**TB**	Transfer image block
K3	Select 3D coordinates	**U**	Upload code
KA	Select absolute coordinates	**V**	Define viewport
KB	Select blank video mode	**WA**	Wedge arc
KD	Select ASCII decimal mode	**WB**	Wedge arc, boundary filled
KF	Select flash video mode	**WF**	Wait for specified number of frames
KR	Select relative coordinates	**WNP**	Write encoded pixels
L	Line	**WNR**	Write encoded graphics RAM
M	Move	**WP**	Write pixels
N	Set pattern register	**WR**	Write graphics RAM
OA	Originate arc	**XB**	Complex boundary fill
OF	Turn video off	**XF**	Complex flood fill
ON	Turn video on	**XHC**	Set crosshair position to current drawing point
OR	OR mode for pixel writes	**XHF**	Crosshair off
P	Polygon	**XHN**	Crosshair on
PAN	Pan video image	**XHP**	Set crosshair position
Q	Define color look-up table value	**XHR**	Return crosshair position
RX	Rotate about *X* axis	**XHS**	Set crosshair size
RY	Rotate about *Y* axis	**Z**	Zoom video image
RZ	Rotate about *Z* axis		
RA	Replace-all made for pixel writes		

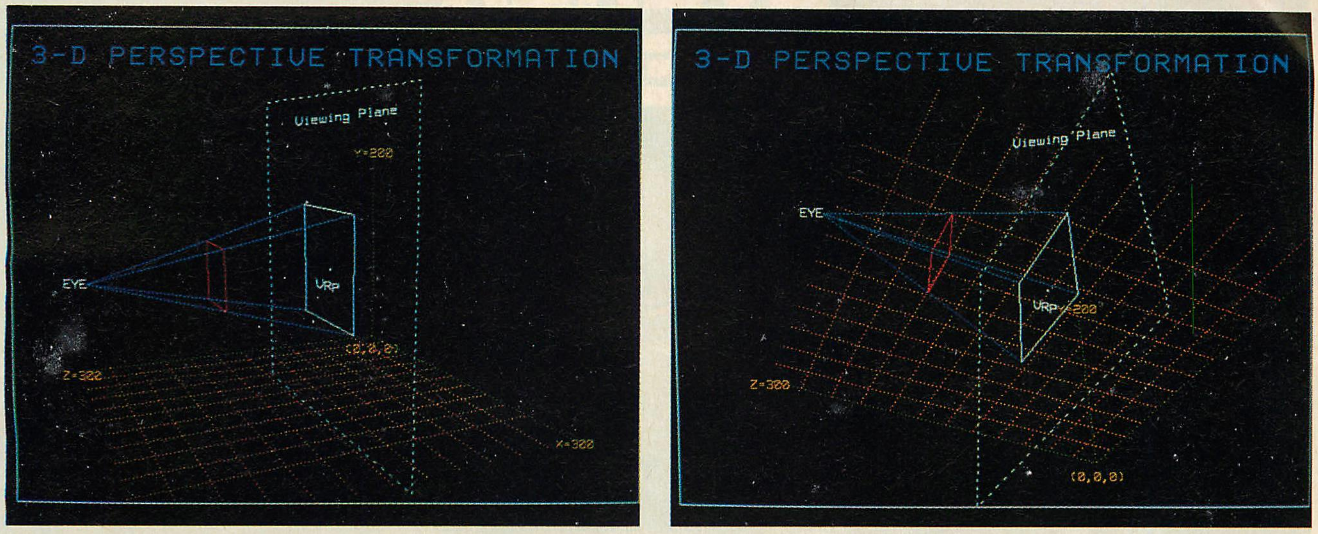
Commands for the Vectrix VX/PC must always be in uppercase ASCII. In hex mode, only the command arguments are sent in binary form.

The PGC maintains two 4-by-4 matrices that operate on all 3-D data points to transform them into new coordinates. The *modeling matrix* is used to translate, scale, and rotate objects in the virtual 3-D coordinate space. Nine separate commands are used for specifying these transformations independently with respect to the *X, Y,* and *Z* axes; a tenth command specifies the entire 16-element matrix.

The *viewing matrix* specifies the orientation of the viewer with respect to the virtual coordinate space. By default, the viewer is positioned 500 units above the *X-Y* plane, looking straight down the *Z*-axis at the origin ($X=Y=Z=0$). The VWRPT command establishes the VRP. The VRP is the translation component of the viewing matrix. Other commands establish the distance from the VRP of the viewer's eye, the angle of view (analogous to specifying wide-angle or telephoto lenses on a camera), and the orientation of the viewer with respect to axes passing through the VRP. These establish the scaling and rotation components of the viewing matrix.

The PGC uses the technique of *hither and yon clipping* in order to exclude certain parts of the virtual image

PHOTO 1: *Viewpoints*



The IBM PGC has built-in commands for 3-D perspective. These images (illustrating the perspective projection) were both made with the commands in listing 1, with different view angles about the *X* axis.

from the displayed image. Two planes are defined at independently specified distances from the viewing projection plane. Lines falling in front of the nearer plane (hither), or behind the farther plane (yon) are clipped so that only the portions between the specified planes are actually drawn.

When the object and viewer positions are established, the (possibly clipped) figure is converted from 3-D into 2-D virtual coordinates by projecting it onto the plane that passes through the VRP perpendicular to the viewer's line of sight. The projection may be from one of two viewpoints: *orthographic* projection ignores depth information and projects parallel rays from the object to the viewing plane; *perspective* projection projects rays from the object to the eye point, thereby giving the familiar effect of distant objects appearing to be smaller. Photo 1 shows the perspective projection of a square onto the viewing plane defined by the VRP. The command file that produces these images is shown in listing 1.

The 2-D virtual coordinates resulting from the 3-D and projection transformations are further changed and displayed exactly as if they had originated as 2-D drawing commands; window-to-viewport scaling, rotation, and clipping all can be applied.

The series of photographs shown in photos 2 and 3 illustrate 3-D rotation, scaling, and translation as performed by the PGC's modeling transformation commands. The upper-left-hand image in each photo shows the object as drawn with the identity transform (MDI). The other three images show the captioned operation.

The PGC uses the right-hand rule model for rotations. In this model the *X* axis increases to the right, the *Y* axis increases upward, and the *Z* axis increases in the direction of the viewer. This can be visualized using a human hand. A positive rotation about any axis will be in the direction of the fingers of a curved right hand where the thumb is pointing toward the increasing coordinates of that axis. Thus for example,

Where the PGC has distinct commands for 2-D and 3-D drawing, the VX/PC has one set of commands that operate differently according to the current drawing mode.

positive rotation about the *Y* axis would move the *Z* axis toward the *X* axis.

Where the PGC has distinct commands for 2-D and 3-D drawing, the VX/PC has a single set of commands that operate differently according to the current drawing mode. In 2-D mode, coordinates are specified by two numbers, *X* and *Y*; in 3-D mode a third *Z* coordinate is added.

The Vectrix 3-D world extends from −32768 to +32767 in each of the three axes, with no fractions allowed. In this system, angles are specified in tenths of a degree.

The VX/PC supports the equivalent of the PGC's modeling matrix transform, but does not have an independent viewing transform. The viewer's eye is always presumed to be at (0,0,0), looking straight down the *Z* axis, which increases away from the viewer. The *X* and *Y* axes are oriented as in the PGC. Clipping in 3-D is also less flexible: anything behind the viewer is considered invisible, as is anything outside the *viewing pyramid*, which has its vertex at the eye point and expands at the viewing angle in both *X* and *Y* directions. The VX/PC has no equivalent of the PGC's yon clipping.

Since the VX/PC has no separate viewing transform, changes in viewpoint must be simulated by moving the objects in virtual space. This can involve translating objects back to the origin, rotating them, and translating them back to new positions.

In 2-D mode, the Vectrix virtual coordinate space is mapped directly onto the screen coordinates, with (0,0) at the lower left corner and (671,479) at the upper right. Scaling in the *X* and *Y* direction can be accomplished with the same scaling commands used in 3-D mode. Rotation about the *Z* axis is also legal in 2-D mode—an effect that is not directly obtainable with the PGC's 2-D commands.

The VX/PC's viewport in 2-D mode serves only to define the clipping boundary within the limits of the actual screen coordinates. Since there is no

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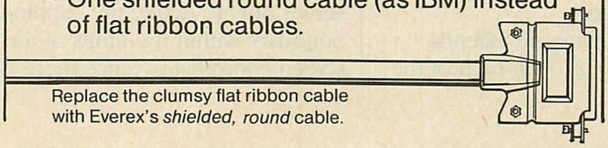

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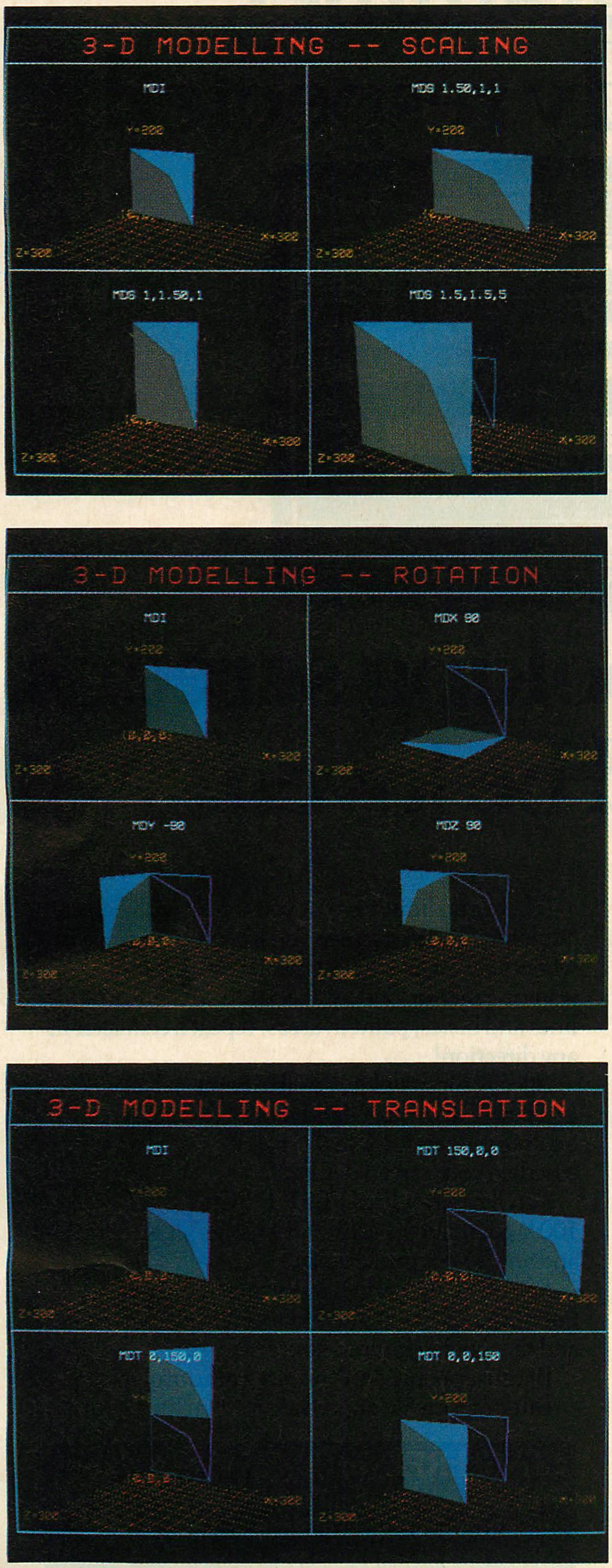
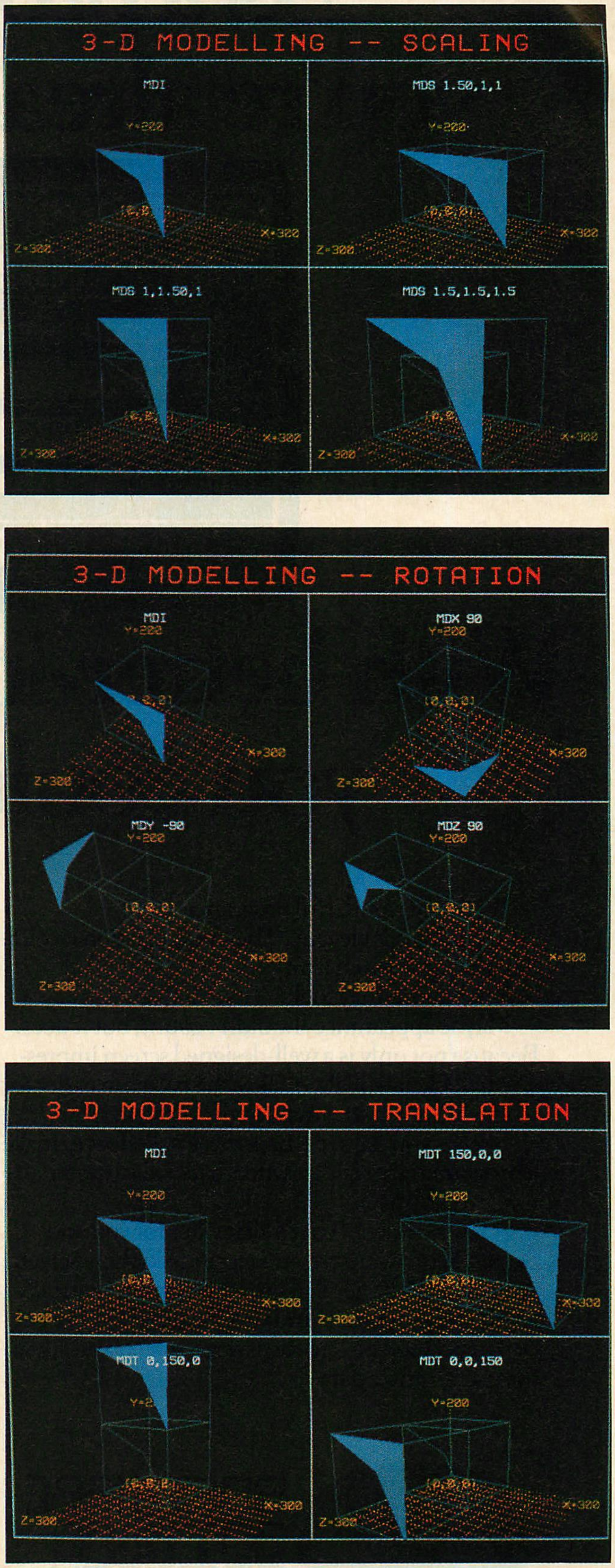
PHOTO 2: *3-D Transformations on Planes*



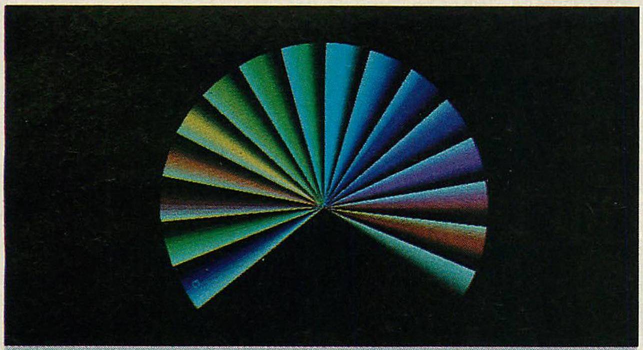
These images, made with the PGC, show the effects of scaling, rotation, and translation of an object in three dimensions. The transformations are with respect to the modeling origin at (0,0,0).

PHOTO 3: *3-D Transformations on Cubes*



The same transformations as in photo 2 are applied to a cube with one corner at the origin. The wire frame model shows the original position, and the solid figure is the result of the PGC command shown.

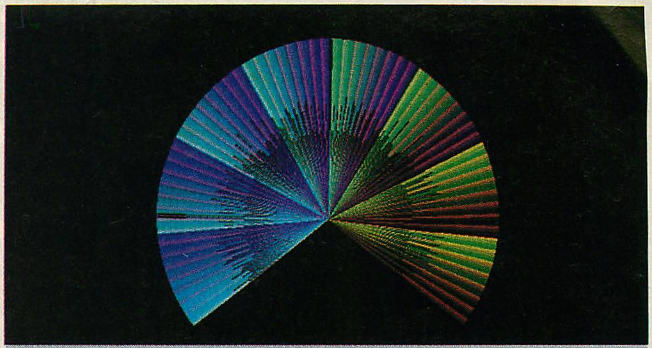
PHOTO 4: *PGC Fan*



```
10 ' FAN.BAS -- for IBM PGC
20 OPEN "pgc" FOR OUTPUT AS #1
30 PRINT #1, "CA rf li 0 f 0 pf 1 di 0"
40 FOR I=0 TO 255
50   A=I-38 '-- (256-180)/2
60   PRINT #1,"C ";I; " S 200 ";A;A+2
70 NEXT I
```

This program produces a fan of 256 adjacent arcs, each filled with a different color from the PGC default color set.

PHOTO 5: *VX/PC Fan*



```
10 ' Draw FAN -- for VX/PC
20 OPEN "vectrix" FOR OUTPUT AS #1
30 PRINT #1, "KD KA RE SV E 0 M 336,240"
40 FOR I=0 TO 511 STEP 2
50   A=(I/2-38)*10 '-- 38=(256-180)/2
60   PRINT #1,"C";I;"WB";I;" 200 ";A;10
70 NEXT I
80 INPUT JUNK$
90 PRINT #1,"SI"
```

The VX/PC version of the fan program uses only 256 of the 512 available colors. Both programs use DOS 2.0 drivers.

windowing function, as exists in the PGC, no scaling is performed by the viewport clipping process.

In 3-D mode, the base of the viewing pyramid in the VX/PC corresponds to the PGC's virtual window and is mapped onto the specified viewport. Thus, the correct aspect ratio is normally preserved only for square viewports. A perspective scaling command is provided to establish the viewing angle in 3-D mode. This scaling command has the side effect of forcing the aspect ratio of the region displayed in the viewport to match the aspect ratio of the virtual coordinate space.

Both the PGC and the VX/PC accept commands in ASCII or binary (misnamed "hex" mode by both manufacturers). The hex mode is faster, since the processor on the graphics card can skip the ASCII-to-binary conversion step and process the data directly. The easier ASCII command mode is used in the programming examples that follow.

The PGC accepts ASCII command arguments in floating-point form. In hex mode, arguments that may have fractional parts are sent as two 16-bit integers, the first representing the integer part of the value, the second the binary fraction (X'8000 is ½).

The VX/PC accepts only integer arguments. Two different schemes are used to ameliorate this restriction: angles are always expressed in tenths of degrees (3600 is 360 degrees), and scale factors are expressed as two integers, where the first is divided by the second (3,5 means 3/5 or 0.6).

Vectrix ASCII mode accepts only uppercase characters, and returns all numbers as five digits, with leading zeroes if necessary. IBM's PGC sends ASCII numbers in variable length strings, separated by commas and terminated by carriage returns.

As mentioned earlier, IBM supplies the low-level VDI driver with the PGC, which is fine for users who already have, or plan to buy, an applications program that uses the VDI interface. Otherwise, the Graphic Development

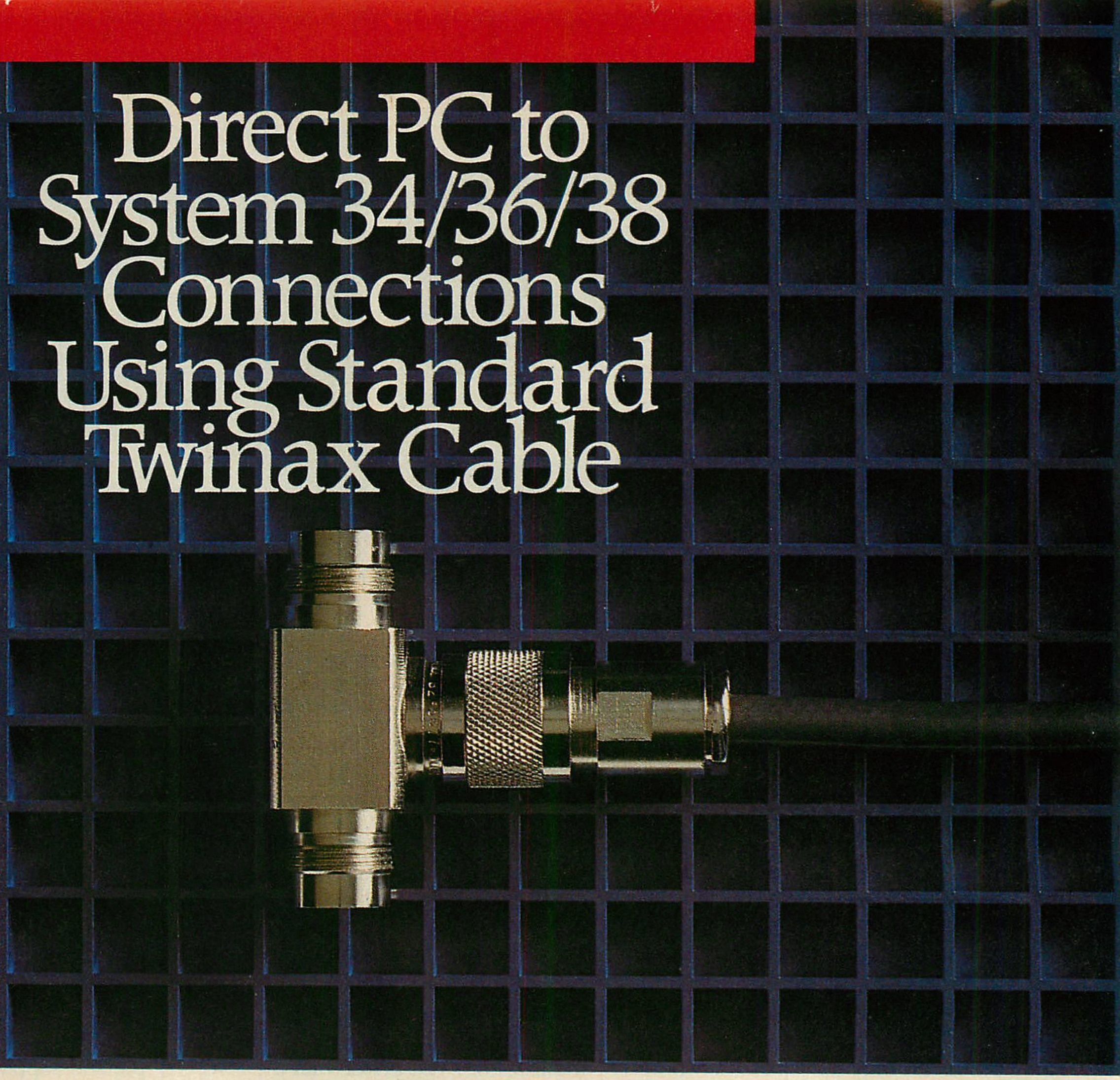
Vectrix supplies a DOS loadable device driver that provides a path to the VX/PC from any DOS program that can open a file and write to it.

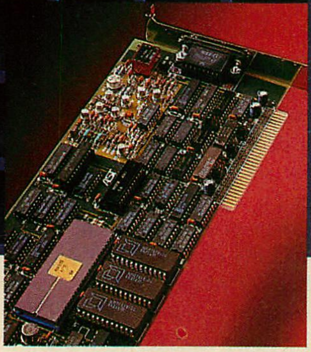
Toolkit ($350) or the Plotting System ($225) is required to use the high function mode without writing custom low-level communications routines.

Vectrix supplies an MS-DOS/PC-DOS loadable device driver that provides a path to the VX/PC from any DOS program, including BASIC, that can open a file and write to it. This is a very handy way to talk to a device such as this—it is simple to use and makes the device instantly available from any standard programming language. IBM must think so too, because its demo programs use just such a mechanism. Unfortunately, that driver is not included with the product, so I had to make my own (see listing 2).

The PGC driver is extremely simple and supports only output to the PGC. Reading back of requested data and error information is not supported, but can easily be done directly from the application or could be added to the DOS driver. The driver code is actually quite small, but it looks big because of the various definitions, header blocks, and dummy routines required of DOS drivers. The model for this driver is the RAM disk driver in the DOS 2.1 *Technical Reference Manual*.

All the real work of the driver program is accomplished in two routines. INIT resets the PGC by setting the cold restart flag at C600:306, then waiting for it to return to 0. OUTPUT handles write requests from the operating system and transfers the data to the PGC's output buffer at C600:0. The output buffer is actually a circular queue, with write and read pointers located at C600:300 and C600:301, respectively. Data are written one byte at a time to the buffer location that is pointed to by the write pointer, then the pointer is incremented. The PGC's processor reads data using the read pointer in a similar fashion. The PGC stops reading when the two pointers are equal, signaling that the buffer is empty. Conversely, the buffer is full when the write pointer is exactly one





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less than the read pointer. In this case, OUTPUT waits until the PGC has processed some bytes from the buffer and incremented the read pointer.

The driver must be assembled with the IBM Macro Assembler, linked, then converted with EXE2BIN to the proper loadable driver format. The final step is to rename the BIN file to IBMPGC.SYS. With the driver installed (by including DEVICE=IBMPGC.SYS in the CONFIG.SYS file and then booting the system), the device can simply be opened and commands written to it. Alternatively, the commands can be written to a disk file, which is later copied to the PGC with another program or the COPY command. The COPY /B form must be used if the command files use the hex command formats.

Photos 4 and 5 illustrate how the two boards' command sets are used to create a nearly identical image, in this case a multicolored fan figure.

PERFORMANCE

Tests were run to gauge the relative performance of the PGC and VX/PC in several different modes (see table 4).

The first tests were in CGA emulation mode. In emulator text mode, the VX/PC is significantly faster than the PGC, but the PGC displays high-quality characters using a 16-by-8 pixel box instead of the less attractive 8-by-8 used by the original CGA and the faithful Vectrix emulation. The VX/PC characters are readable, but as unattractive as those on the CGA, while the PGC characters looked every bit as good as those on the standard Monochrome or Enhanced Graphics adapters. If one of these boards is to be the only display device in a system, a trade-off will have to be made between speed and beauty.

In emulator graphics modes, both boards performed equally well. The VX/PC emulation is done entirely in hardware, while the PGC uses a combination of hardware and software in the display microprocessor.

The high-level graphics functions were tested with some simple BASIC programs and the appropriate DOS driver. All commands were sent in ASCII format. The hex format commands should go even faster, since generally fewer bytes have to be transferred, and the display processor does not have to do as much work to put the data into its preferred internal form.

The PGC is the hands-down winner in the high-level drawing contest. The first program filled the screen with concentric circles to test the circle algorithm and 2-D clipping. The PGC was

TABLE 4: *Benchmarks*

	PGC	VX/PC
CGA EMULATION		
Characters (screen 0)	19 secs	7 secs
Characters (screen 2)	8	8
Line drawing (screen 2)	54	54
HIGH FUNCTION 2-D GRAPHICS (ASCII)		
Concentric circles (206)	11	29
Open polygons (65)	8	12
Filled polygons (65)	18	619
IMAGE TRANSMISSION		
Synthesized (turbine 28KB)	3	26
B/W photograph (landscape 118KB)	8	—
Color photograph (mandrill 226KB)	14	—
Unencoded using DMA (364KB)	N/A	6

In emulator text mode, VX/PC is faster, but its characters are not as attractive as those for the PGC. In high-function graphics, the PGC is the clear winner, but the VX/PC has the edge in image transmission with its DMA transfer capability.

TABLE 5: *Drawing Times*

MASK (hex)	NUMBER OF PLANES	OPEN POLYGONS PGC	OPEN POLYGONS VX/PC	FILLED POLYGONS PGC	FILLED POLYGONS VX/PC
01	1	8 secs	7 secs	110 secs	283 secs
03	2	8	7	110	283
07	3	8	8	110	283
0F	4	8	8	18	283
F0	4	8	9	18	283
1F	5	8	10	110	283
3F	6	8	10	110	283
7F	7	8	11	110	283
FF	8	8	11	18	283
100	1	N/A	7	N/A	283
1F0	5	N/A	10	N/A	352
1FF	9	N/A	12	N/A	619

Times given are total drawing times, from first command sent to last image drawn with the TIME$ function in BASICA. Commands are transmitted in ASCII mode. Program execution times (as opposed to drawing times) for the PGC are actually shorter than shown, due to IBM's 256-byte command buffer. The VX/PC buffers one command at a time; it hands in a better performance with fewer planes to write.

PHOTO 6: *Screen Comparison*

Identical areas of image are displayed on the Vectrix VX/PC (left) and the IBM PGC (right). The Vectrix display is interlaced, resulting in more visible scan lines.

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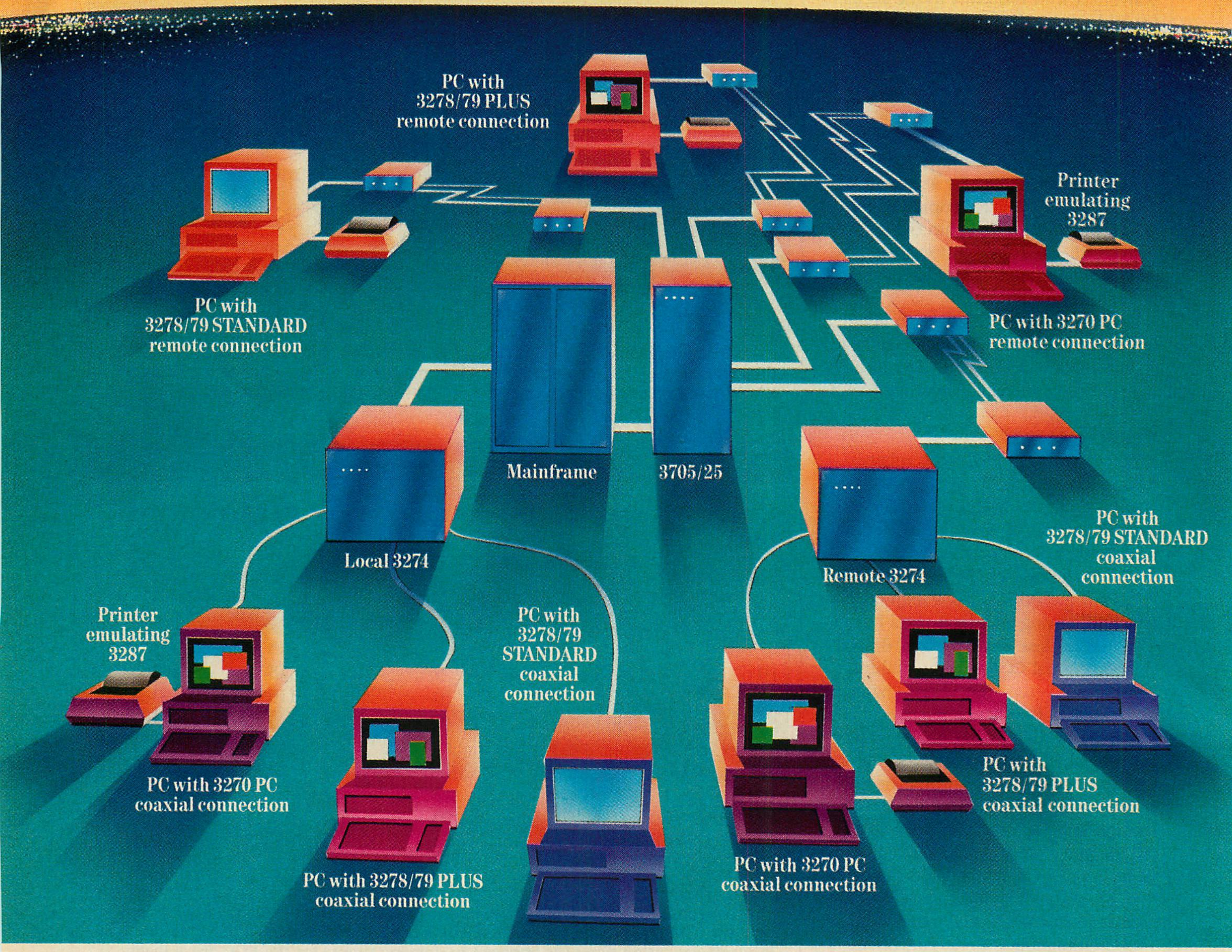

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nearly three times faster than the VX/PC. The second test drew 65 large triangles, each in a different color. The difference here was smaller, but still substantial: the VX/PC was 50-percent slower.

The third test produced some surprising results. The same 65 triangles (each approximately half the area of the screen) were drawn with the fill option, so they appeared solid rather than outlined. The Vectrix system took 9.5 seconds for *each* triangle; the IBM system did all 65 in only 18 seconds. The performance ratio was more than 34 to 1.

Up to this point, the tests had all been carried out with the default bit plane mask setting that enabled all eight planes in the PGC or all nine planes in the VX/PC. The tests were run again, this time with fewer planes enabled. Table 5 shows the results of the polygon test with different plane masks. The VX/PC hands in a better performance with fewer planes to write. With only one or two planes enabled, it is slightly faster (in ASCII mode) than the PGC is at 2-D line drawing.

The PGC is only slightly affected by varying the number of plane masks. Line drawing times remain fairly constant regardless of the mask. Area fills go fastest with masks of X'FF, X'F0, or X'0F. The VX/PC is always much slower at filling, but the penalty is much greater in going from eight to nine bit planes. The moral here is that the hardware architecture really does affect the performance. Knowing this, it is possible to improve the performance of the VX/PC by carefully setting up the color look-up table to allow images to be drawn with the minimal number of bit planes. The PGC, by contrast, does not gain from masking out any of its planes.

Picture files supplied by the manufacturers with their demo units were used to run the image transfer test. Both systems support pixel-by-pixel transfers in run-length encoded form of all or part of the screen image. Fortunately, one image file showed up in both demo packages—an exploded view of a turbine rotor, courtesy of Raster Technology Inc. of Billerica, Massachusetts (see photo 6). Although the encoding schemes are not identical, each file was within 300 bytes of 28KB, with the VX/PC image about 20-percent smaller than the IBM version. No matter, IBM put it up in 3 seconds and Vectrix took 26, almost nine times longer.

Larger, more complex image files took longer, of course. A full-color digitized photograph of a mandrill supplied by IBM, which weighed in at 226KB, displayed in 14 seconds using COPY /B and the simple DOS driver. A 16-level monochrome landscape picture of 118KB took 8 seconds to appear. Measurements were taken on a standard PC or XT with a fixed disk; the times include reading the disk files.

The VX/PC has a much greater variety of existing applications software currently available for it than for the PGC, which is to be expected given Vectrix's year-long head start.

The most amazing feat in the image transfer category belongs to Vectrix. The enhanced model of the VX/PC boasts a DMA transfer capability, which allows a transfer of *unencoded* image data to go directly from PC memory to the VX/PC graphics memory at bus speed. The DMA transfer takes place in less than six seconds. Vectrix claims the memory transfer time is about 1.5 seconds. The restriction is that an unencoded Vectrix image is a little more than 364KB, which is a little more than a standard 360KB diskette can hold; so a hard disk (or at least a 1.2MB diskette) is necessary for the DMA transfer.

DMA mode can also be used to transfer normal drawing commands and encoded image data, but there is no discernable performance improvement, since the bulk of the time spent processing those commands involves work by the 80188 processor to decode the commands and perform the operations.

IMPRESSIVE PRODUCTS

While the IBM product seems to have a clear performance advantage, the VX/PC will perform more than adequately for many applications. The benchmarks done for this article do not tell the whole story, and it would be foolish to choose the PGC over the VX/PC solely on the basis of these limited tests.

The VX/PC has a much greater variety of applications software available for it than for the PGC, which is to be expected given Vectrix's year-long head start and its previous experience in the graphics field with a similar stand-alone product called the VX/128.

The PGC command set is more consistent, and it seems easier to remember the format and effect of the various commands than it does for the VX/PC command set. This consideration will, of course, mean nothing to users of software supplied by someone else.

For users wanting to do their own programming, the documentation and support included with the VX/PC may be a deciding factor. IBM was negligent in not only leaving out the *Options and Adapters Technical Reference*, but also in making it difficult to obtain.

The pictorial images of both the PGC and VX/PC are of considerably high quality. The convincing appearance of these images is due more to the variety of colors (or intensities in the case of monochrome images) than to the high pixel resolution.

The PGC can display 256 colors at a time, and the VX/PC can display 512 colors. At first glance this seems like a big difference, but really it is not for many applications. Both systems use 4 intensity bits for each primary color (red, green, and blue), giving 16 intensities for each and a palette of 4,096 possible colors. The IBM mandrill picture, for example, which uses fewer than 256 colors, is of near-photographic quality. Many business and engineering applications will do fine with just 16 colors. In solid modeling and image processing applications, the VX/PC's additional colors (and the optional 16.8 million-color palette with 256 intensities for each primary) are more likely to be a deciding factor.

Both the PGC and VX/PC are high-quality products with a wide variety of applications in graphics arts, engineering workstations, image processing, and many other fields.

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Thomas V. Hoffmann is director of advanced systems development for General Instrument Corporation. He is a consulting editor to this magazine. His last article was a review of the IBM Enhanced Graphics Adapter, appearing in the April 1985 issue.

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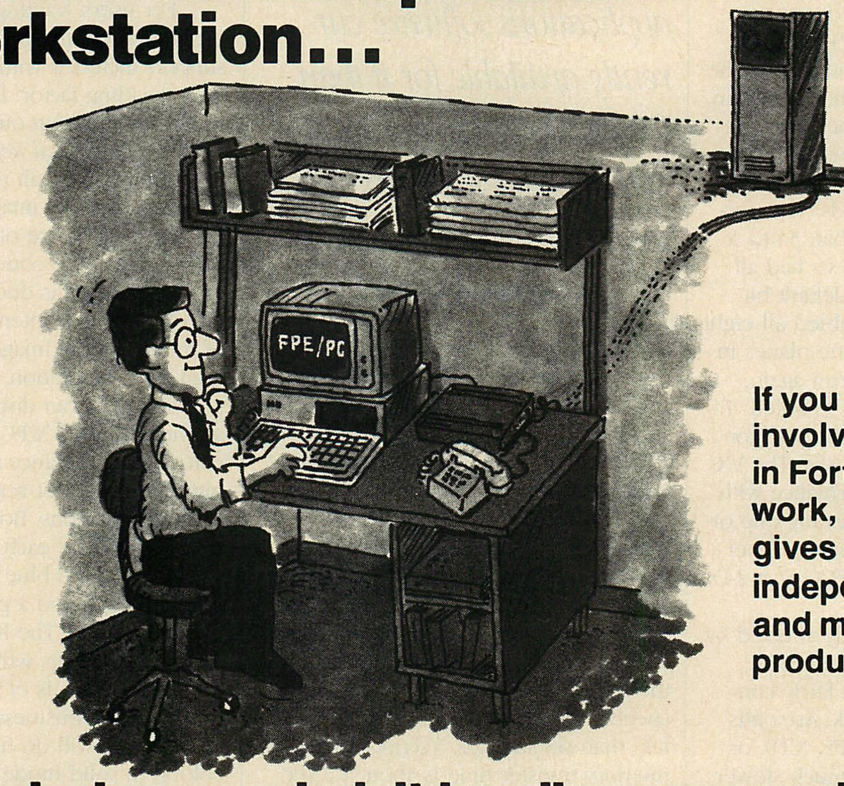

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LISTING 1: PERSPECT.DAT

```
ca di 0 rf li 1
vwrpt 100,100,100 distan 600 vwy 65 vwx -10

vwport 0,639 0,479
f 1

c 0
m 0,200 ts 20 tj 2 1 t '3-D PERSPECTIVE TRANSFORMATION'

c 3 ts 8
m3 0,-10,0 convrt tj 2 3 t '(0,0,0)'
lp 4369
m3 0,0,0  dr3 300,0,0 convrt t 'X=300'
m3 0,0,0  dr3 0,200,0 convrt t 'Y=200'
m3 0,0,0  dr3 0,0,300 convrt t 'Z=300'

c 6
m3 0,0,300
cb 1 mr3 25,0,-300 dr3 0,0,300 ce cl 1 10
m3 300,0,0
cb 1 mr3 -300,0,25 dr3 300,0,0 ce cl 1 11

c 3 lp 65535
m3 100,100,100
c 15 pr3 4 -50,-50,0 -50,50,0 50,50,0 50,-50,0
m3 100,100,100
c 5
pr3 4 -25,-25,100 -25,25,100 25,25,100 25,-25,100

c 15
m3 100,100,300 convrt tj 3 2 t 'EYE'
m3 100,100,100 convrt tj 1 2 t '.' mr 0,-20 tj 2 2 ta -16 t 'VRP' ta 0
convrt mr 20,150 ta 10 tj 2 2 t 'Viewing Plane' ta 0

lp 3598
m3 100,100,100
pr3 4 -145,-145,0 -145,145,0 145,145,0 145,-145,0

c 0 lp 61166
m3 100,100,300 dr3 50,50,-200
m3 100,100,300 dr3 50,-50,-200
m3 100,100,300 dr3 -50,50,-200
m3 100,100,300 dr3 -50,-50,-200

c 15 lp 65535
m -320,-240 rect 319,239
```

LISTING 2: IBMPGC.ASM

```
TITLE   IBM PGC Output Driver -- T. Hoffmann April 1985
PAGE    60,132
;
; File: IBMPGC.ASM
; Auth: T. Hoffmann -- April 1985
; Edit: TVH  5-Apr-85  5:40pm
;
; DOS 2.x Loadable Device Driver for
;_   IBM Professional Graphics Adapter
; Device name: PGC:
; Character device, supports output only.
;
;----------
; Macro to set Return Status
;
STATUS  MACRO   STATE,ERR,RC
        IFIDN   <STATE>,<DONE>
        OR      ES:WORD PTR SRH_STA[BX],0100H
        ENDIF
        IFIDN   <STATE>,<BUSY>
        OR      ES:WORD PTR SRH_STA[BX],0200H
        ENDIF
        IFIDN   <ERR>,<ERROR>
        OR      ES:WORD PTR SRH_STA[BX],1000H
        ENDIF
        IFNB    <RC>
        OR      ES:WORD PTR SRH_STA[BX],RC
        ENDIF
        ENDM
;
; PGC Memory Definitions
;
PGCSEG  SEGMENT AT 0C600H
OUT_FIFO        DB      256 DUP(?)
IN_FIFO         DB      256 DUP(?)
ERR_FIFO        DB      256 DUP(?)
OUT_WP          DB      ?       ; Output Write Pointer
OUT_RP          DB      ?       ; Output Read Pointer
IN_WP           DB      ?       ; Input Write Pointer
IN_RP           DB      ?       ; Input Read Pointer
ERR_WP          DB      ?       ; Error Write Pointer
ERR_RP          DB      ?       ; Error Read Pointer
COLD_RESET      DB      ?       ; Cold Reset Flag
WARM_RESET      DB      ?       ; Warm Reset Flag
ERROR_ENABLE    DB      ?       ; Error Enable Flag
SECRET          DB      3 DUP(?); -- Who knows? --
DISPLAY_SET     DB      ?       ; 0=High Function, 1=Emulator
DISPLAY_STAT    DB      ?       ;  ....
PGCSEG  ENDS
;
CSEG    SEGMENT PARA PUBLIC 'CODE'
;
; I/O Request Header
;
SRH             EQU     0       ;Static request header start
SRH_LEN         EQU     SRH     ;Legnth field
SRH_UCD         EQU     SRH+1   ;Unit code field
SRH_CCD         EQU     SRH+2   ;Command code field
SRH_STA         EQU     SRH+3   ;Status field
SRH_RES         EQU     SRH+5   ;Reserved area field
;
;       INIT data
;
END_ADDRESS_0   EQU     SRH+14  ;Ending address of handler
END_ADDRESS_1   EQU     SRH+16
;
;       I/O  data
;
BUF_ADDRESS_0   EQU     SRH+14  ;Buffer address
BUF_ADDRESS_1   EQU     SRH+16
BYT_COUNT       EQU     SRH+18  ;Number of bytes to transfer
;
;----------
PGC     PROC    FAR
        ASSUME  CS:CSEG,ES:CSEG,DS:CSEG
BEGIN:
START   EQU     $
;
;       Special device header
;
NEXT_DEV        DD -1           ;Pointer to next device
ATTRIBUTE       DW 8000H        ;Attribute for char device
STRATEGY        DW DEV_STRATEGY ;Pointer to device strategy
INTERRUPT       DW DEV_INT      ;Pointer to device interrupt
DEV_NAME        DB 'PGC     '   ;Name of this driver (8 chrs)
;
;       Storage for Request Header info
;
RH_OFF          DW      ?       ;Offset of request header
RH_SEG          DW      ?       ;Segment of request header
;
;       Function table -- routine addresses
;
FUNTAB  LABEL   BYTE
        DW      INIT            ;Initialization
        DW      MEDIA_CHECK     ;Media check (BLOCK ONLY)
        DW      BUILD_BPB       ;Build BPB (BLOCK ONLY)
        DW      IOCTL_IN        ;IOCTL input
        DW      INPUT           ;Input (read)
        DW      ND_INPUT        ;Non-destructive input (CHAR)
        DW      IN_STAT         ;Input status (CHAR ONLY)
```

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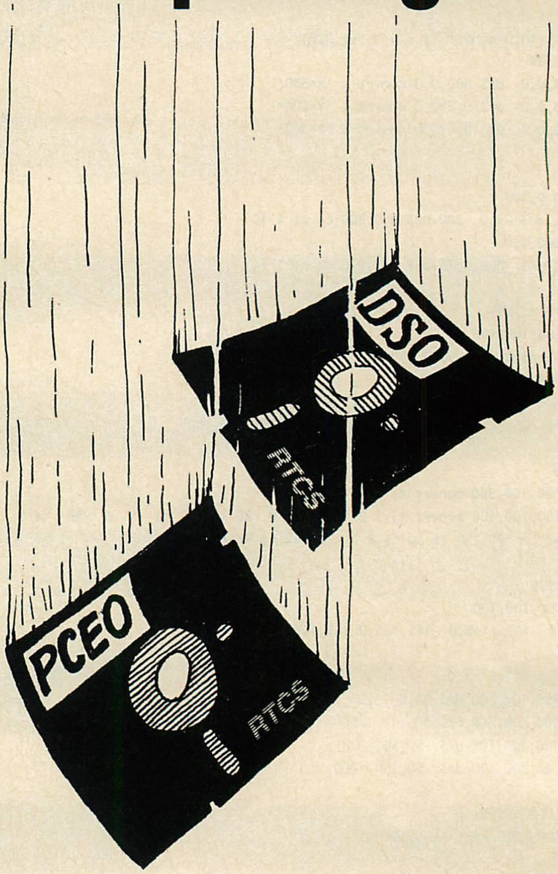

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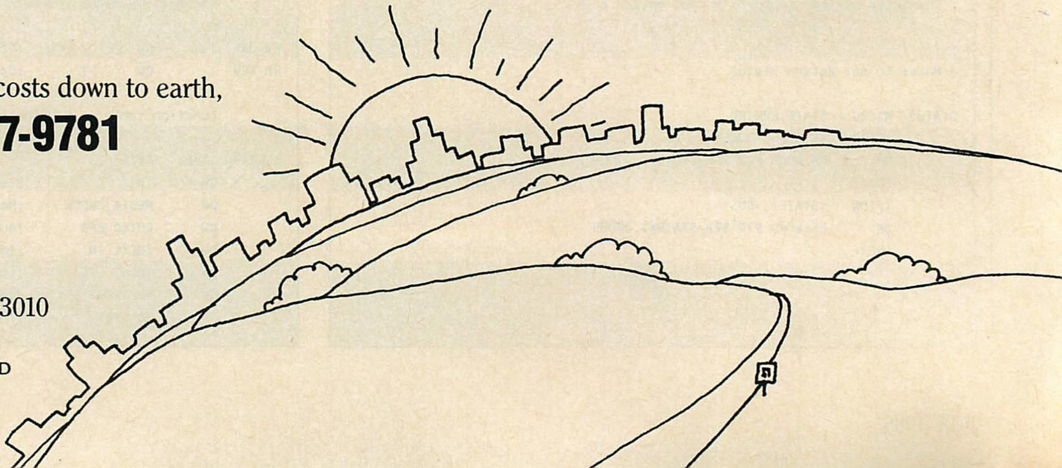

RTCS

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```
        DW      IN_FLUSH        ;Input flush (CHAR ONLY)
        DW      OUTPUT          ;Output (write)
        DW      OUT_VERIFY      ;Output with verify
        DW      OUT_STAT        ;Output status (CHAR ONLY)
        DW      OUT_FLUSH       ;Output flush (CHAR ONLY)
        DW      IOCTL_OUT       ;IOCTL output
;
;
;       D E V I C E   S T R A T E G Y
;
DEV_STRATEGY:
        MOV     CS:RH_SEG,ES    ;Save segment of request hdr
        MOV     CS:RH_OFF,BX    ;Save offset of request hdr
        RET
;
;
;       D E V I C E   I N T E R R U P T   H A N D L E R
;
DEV_INT:
        CLD             ; Save just about everything
        PUSH    DS
        PUSH    ES
        PUSH    AX
        PUSH    BX
        PUSH    CX
        PUSH    DX
        PUSH    DI
        PUSH    SI
;
;       Branch according to function passed
;
        MOV     AL,ES:[BX]+2
        ROL     AL,1
        LEA     DI,FUNTAB
        XOR     AH,AH
        ADD     DI,AX
        JMP     WORD PTR[DI]

;----------
; Unsupported functions
;
IOCTL_IN:
IOCTL_OUT:
INPUT:
ND_INPUT:
IN_STAT:
IN_FLUSH:
OUT_FLUSH:
MEDIA_CHECK:
BUILD_BPB:
        STATUS  DONE,ERROR,03   ;Set command unknown error
        JMP     EXIT

;----------
; Init -- Called once at system startup
INIT:
        PUSH    CS              ;Get CS to DX
        POP     DX
        LEA     AX,CS:PGMEND    ;Get end of program
        MOV     CL,4
        SHR     AX,CL           ;Divide by 16 (paragraph form)
        INC     DX              ;Point to next segment
        ADD     DX,AX           ;Add to current CS value
        MOV     ES:WORD PTR END_ADDRESS_0[BX],0
        MOV     ES:END_ADDRESS_1[BX],DX
;
; Cold Start PGC and Wait for Ready
;
        PUSH    DS
        MOV     AX,PGCSEG
        MOV     DS,AX
        ASSUME  DS:PGCSEG
        MOV     COLD_RESET,1
INIT1:  CMP     COLD_RESET,0
        JNE     INIT1
        POP     DS
        ASSUME  DS:CSEG
```

```
;
; Intercept Keyboard Interrupt for Alt-Esc Mode Switch
;
        ;Later

        STATUS  DONE,NOERROR,0
        JMP     EXIT

;----------
; Output
;
OUTPUT:
        PUSH    ES              ;Save request packet pointer
        PUSH    BX
        ;Get buffer pointer and character count
        MOV     DX,ES:WORD PTR BUF_ADDRESS_1[BX]
        MOV     AX,ES:WORD PTR BUF_ADDRESS_0[BX]
        MOV     CX,ES:WORD PTR BYT_COUNT[BX]
        ;Use ES:BX to point to buffer
        MOV     ES,DX
        MOV     BX,AX
        MOV     AX,PGCSEG
        MOV     DS,AX
        ASSUME  DS:PGCSEG
CHKSPC:                                 ;Wait for FIFO space
        MOV     AL,OUT_WP               ;Full only if WP+1=RP
        INC     AL
CHK2:
        CMP     AL,OUT_RP
        JE      CHK2
        DEC     AL
        MOV     AH,0                    ;Form next address
        MOV     SI,OFFSET OUT_FIFO
        ADD     SI,AX
        MOV     AL,ES:[BX]              ;Get a byte
        MOV     [SI],AL                 ; and store it
        INC     OUT_WP                  ;Bump Write Ptr
        INC     BX                      ;Pt to next char
        LOOP    CHKSPC                  ;Go until CX=0

        POP     BX                      ;Restore Buffer ptr
        POP     ES
        STATUS  DONE,NOERROR,0
        JMP     EXIT
        ASSUME  DS:CSEG

;----------
; Output with verify
;
OUT_VERIFY:
        JMP     OUTPUT
;
;       Output status
;
OUT_STAT:
        STATUS  DONE,NOBUSY,0
        JMP     EXIT

;----------
; Common Exit Path
;
EXIT:
        POP     SI
        POP     DI
        POP     DX
        POP     CX
        POP     BX
        POP     AX
        POP     ES
        POP     DS
        RET

PGC     ENDP
PGMEND  EQU     $
CSEG    ENDS
        END     BEGIN
```

PC BRAND™'s CRAFTSMAN™ TOOLS FOR C PROFESSIONALS

LIBRARIES: *Hundreds of Functions for Fast Programming*

C is a bare-bones language. It does not have built-in (machine dependent) functions for printing or floating point math or string manipulation. That's why it's so portable. That's also why libraries of pre-written functions are such big sellers: bullet-proof routines your application can effortlessly call to get the job done.

GREENLEAF FUNCTIONS

More than 200 functions in C and/or assembler source, and a 200 page manual with examples and demos.

32 DOS extensions: file and directory manipulation for DOS 1.1 and 2.0.

23 Screen Functions: Select mode, page, monochrome or color, palette; cursor shape, positioning; clearing and scrolling; character reading and writing with attribute and color control; pixel get and put; read light pen.

60 String Functions: Manipulation of strings including center and justify; efficient list operations which add, delete, and sort pointers to strings for top speed.

50 Graphics Functions: Primitives to access all graphics; typeface, formatting, and forms control for IBM Graphics Printer.

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Product Code: S0770 # Our Price:
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GREENLEAF COMMUNICATIONS

Want your application to communicate with other users or remote date bases? Now you can build asynchronous communications right into your C programs!

Over 60 functions set up an interrupt driven scheme with separate transmit and receive ring buffers (characters are simultaneously loaded at one end and transmitted from the other, or vice versa) for an arbitrary number of ports. Interrupt control means you can download a record, then halt the incoming stream to file it, display it, let the user tamper with it, send it back up line. It all happens within the context of *your* program, using your user commands, and does away with the sidestep to the separate communications software (and its semantics) you had to use until now.

The Greenleaf Comm Library supports ASCII or binary, any parity, any word length, 8250 UARTs, all four Lattice C memory models, Hayes 300, 1200, 1200B and other modems.

Its 80-page manual has examples of each function, discusses asynchronous communications, and both the library and demo programs come with source (a mix of C and assembler)!

Product Code: S0750 # Our Price:
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Decimal Arithmetic: Trigonometric, logarithmic functions, powers, conversion to strings, BCD operations for numbers up to 16 significant digits.

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Terminal Independence Package lets you move programs to computers with other types of terminals.

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Quite a treasure. So cost effective that after using only a couple of functions you'll be saving a bundle compared to writing your own. (It's true; how much do you cost per day?). So why not go for the whole bundle!

LATTICE WINDOW
All Your Applications Could Have Windows!

Windows are no gimmick. Ask any user of a windowed product.

But how do you add this technique to your applications without disappearing for several months of R&D?

With Lattice Window.™ A rare programming tool which will change the way you think of program design. Lattice Window takes over all screen management. It is an extensive set of object code functions which you merely call from your C program.

Think of a window as a screen of flexible size. You can tell Lattice Window to open and close up to 255 virtual screens from 1x1 to 255x255 bytes. Then tell "Window" to display any portion of these virtual screens on the physical screen — as many as fit — wherever you want, overlapping and overlaying at will.

Windows no longer needed may be closed. Any background area overlaid earlier (which could be corners of several windows) will pop back to the screen. Think for a moment what a programming job that technique represents.

To your program, the entered window is the *entire* screen — all row and column references are relative to the window no matter its absolute position in the screen. All scrolling occurs only within the active window. The cursor will not leave its boundaries until your program says to.

- You can move a window on the screen.
- You can grow it to display more of the underlying virtual screen. Or shrink it.
- You can control screen attributes (color, blinking, inverse video, etc.).
- You can direct output to either the monochrome or color board.

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MULTI-HALO
MORE BOARDS!
Premier Graphics Library Now Supports 21 Boards

Halo has become so dominant a graphics standard that the newest incarnation, Multi-Halo, supports 21 graphics cards, and comes with a multitude of mouse and printer drivers. All with one purchase, replacing the previous one board per copy. The latest version adds support for the AT&T 6300 and the IBM enhanced graphics card.

Within your Lattice program a function call can reset drivers. You can arrange that your application program doesn't care what board the customer has; you can even switch boards within a program, as when two different monitors are used.

Halo is a complete library of graphic functions which can be linked with your Lattice programs to create full-color charts, graphs, simulations, animation.

Over 100 commands are at your disposal, including plot, line, arc, box, circle, plus single commands to produce bar graphs and pie charts. Pattern-fill and dithering commands give your graphics impressive texture and color mixes, rubber-banding draws shapes for interactive users, area moves produce animation, fill and flood commands paint areas. Multi-Halo allows you to define your own world coordinate scheme, divide the screen into windows, and scale graphic figures automatically.

Product Code: S0550 Our Price:
List Price: **$250.00** **$199.00**

PMATE
The Programmer's Word Processor

Pmate™ was designed for programmers. We'll wager that you cannot find a programmer who has discovered Pmate and moved on to something else.

Pmate is a full screen editor with ten auxiliary buffers for squirreling away pieces of text until needed. It uses single key commands to move the cursor, or text, or insert or delete, or rescue several thousand characters of deleted text.

It has a format mode for tab setting or wraparound and shaping when it's time to write documentation. Pmate lets you assign chains of commands or strings of text to single keys: a keystroke could set up the entire shell of a new C function, for example.

Pmate has variables, if-then statements, loops. It calculates, and converts decimal to hex to binary and back. You can write compact programs (called "macros") to delete comments, for example, or check syntax, or process long sequences of commands. Macros can alphabetize lists, do row and column math, perform a series of operations on multiple files, even summon other macros.

Put another way, Pmate is a text editor with its own built-in interpretive language. A language you can use to completely customize this text editor to your fancy. Possibly the most artful, ingenious program you have ever seen.

Product Code: S0600 # Our Price:
List Price: **$225.00** **$175.00**

Dr. HALO

Multi-Halo is a library of functions to utilize from your C program. Dr. Halo is a standalone program, written in Halo. Its dazzling. Your screen becomes a canvas, and a mouse (preferable) your paintbrush to take you wherever your imagination leads. Save the images to disk, run them by with Dr. Halo's slide show feature. Suggestion? Use Dr. Halo as a freehand sketchpad to design what you want your application to do. So you can see the end result you're after when you start to code.

Product Code: S0320 Our Price:
List Price: **$99.00** **$75.00**

BASIC_C
Use Your Knowledge of BASIC to Learn C

If you're getting the message that switching from BASIC to C would be prudent, you're about to discover that it's back to basics of a different sort. BASIC is fat with hidden functions that stripped down C just doesn't have.

Gone are all those handy string manipulators like LEFT$, MID$, STRING$, etc. In C, when you reach for even simple invocations like INPUT or PRINT A$,X% — well, underlying such expressions in BASIC are bulging macros which C cannot have if it is to keep its slim profile.

But now comes BASIC_C and all your old favorites are back. Someone has written the full set of C functions to mimic BASIC's vocabulary, from ABS to WRITE. Over 80 routines to open and close files, "field" file buffers, convert their contents from and to strings (the CV? and MK? series), peek and poke, print using, clear screen, "instr", on error goto. . . they're all there. Some have reworked names and syntax to suit C, but all are written as one-to-one functional equivalents to the familiar features of BASIC. And they are documented one to a page in alphabetical sequence like the Microsoft manual for added familiarity.

So with BASIC_C, when you're thinking INPUT, go ahead. Use it. Or LPRINT or LOCATE or INKEY. But without BASIC_C, you will find that every line of code plunges you back in the C texts to figure out how to write it. Someday you'll want to, but for now, BASIC_C will start you programming quickly at the statement level so that you can concentrate on C's larger concepts.

There's a bonus: an unusually well-written manual with a first rate chapter comparing how BASIC and C go about their tasks. Without question, BASIC_C will ease your transition to C.

Product Code: S0350 # Our Price:
List Price: **$175.00** **$145.00**

BASTOC
It Translates Your BASIC Programs Into C

You'd like to upgrade C, but what to do with that warehouse of BASIC routines you've carefully polished over the years? And how to face converting your famous Leviathan accounting system from BASIC, much less your Labyrinth file management package?

With BASTOC,™ a translator which takes in BASIC source code and emits pure Kernighan & Ritchie C. Our BASTOC understands Microsoft Extended BASIC (except for dynamic dimensioning and common). It will optionally convert your program into a single monolithic C function or will decompose it into separate functions, one for each GOSUB label.

Strings are dynamically allocated in the target program, ridding your application of BASIC's catatonic halts for garbage collection. BASTOC will try to create structure of even the most convoluted BASIC code, and writes any indigestible statement into the C output as a comment plus explanation. Also, you optionally can tell BASTOC to insert BASIC source lines into the C target as comments.

Source code of several modules of the translator and library are provided so you can tailor BASTOC to your environment if needed. And source of the entire product is for sale.

Product Code: S0370# Our Price:
List Price: **$350.00** **$280.00**

HIGH SPEED SOLUTIONS FOR APPLICATIONS DEVELOPMENT

BTRIEVE

Arguably the Best B-Tree File Handler Available

If your programming still gets anywhere near the files, here's our guarantee: *Nothing* will increase your productivity faster than handing the filing job to a *sophisticated file manager.*

Btrieve™ takes complete charge of all file indexing, reading, writing, insertion and deletion. Its 22 commands are library function calls which will accomplish everything you need to manipulate data files: create, open, and close files; delete and insert records, recapturing vacated space; find records which exactly or most nearly match keys; walk files by ascending or descending key.

Btrieve's foundation is a balanced-tree indexing scheme, conceded to be the fastest search technique devised (it will find any key in a million-plus item index in four or less accesses).

Btrieve comes with interfaces to C, and IBM Pascal, BASIC, and COBOL, and the manual gives you working sample programs which demonstrate every command in all four languages. The kind of presentation which led *PC World* to exclaim "for those of us who have endured poorly written. . .manuals, this one is a pleasure."

Btrieve has mainframe specifications! A single file may have up to 24 indexes. Segments of keys may be indexed. Each index can independently accept or block duplicate keys. A record length can be up to 4090 characters; an index length 255 characters. A file may be 4 billion bytes. It can even extend a file across two drives — even two hard disks!

With Btrieve you are freed to think logically; the physical file is no longer of concern. Gone for good is all that time-wasting dickering with intricate file referencing schemes and sorting algorithms.

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Version 6 Adds the 3rd Dimension

The newest version of this premier programming tool lets you layer your screen designs with up to ten overlapping images, making it easy to background a screen with pop-up lists, help boxes, and alternate sets of input fields.

Writing your own screenware is a good way to blow completion dates and profits. Panel™ works with you interactively to set up foolproof screen displays and data entry forms rapidly. It tests your form to prove that it (and test data) behave correctly, then converts the finished work into C source code for incorporation into your application, and compilation with Lattice.

Wonderfully diverse attributes may be selected for any field — size, data type, color, of course, but also: conversion of input to upper case; clearance of existing data when new entry is started; masks for standard formats (e.g., dates, phone numbers); a choice of styles for numeric fields; phrases which fill in when their first letter is typed; multiple-choice lists from which to choose a field fill-in by cursoring a highlighted bar. Fields may be multi-lined (e.g., name and address as one field) and scrolled if larger than the screen space allotted them.

Panel builds in a user interface for keystroke movement within and between fields, and supplies extensive validation routines for checking user field entries — in source code, so you can tack on your own unique variants.

Panel's screen layouts can be assigned to individual windows under Lattice Window control. Screen designs may be dynamically loaded from file, or compiled into a program, and version 6 has optimized code to quicken display speed.

The whole package is wrapped in a monitor and keyboard customization package to tailor* your application for other equipment.

Panel. A superior productivity tool now bigger than ever.

Product Code: S0400 #* — Our Price:
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*"Tailor" needs separate license to distribute with your programs

PLINK86

Size Unlimited with This Overlay Linker

Software is becoming ever more sophisticated, which means more complex programs needing large chunks of memory. But if you use extra memory, you are counting on users to have expanded RAM, and will forego sales to those who do not.

Plink86™ is the answer. It shoe-horns large programs into small memory. First, Plink86 acts as an alternative to DOS' Link. C encourages design of separately compiled object modules in the Microsoft relocatable format. Plink86 pulls modules together into single compiled programs. But Plink86's overlay power is what has gained it a reputation as a miracle worker. It binds into the compiled program its overlay manager which knows how to swap modules of your large linked program between disk and memory, so that each can temporarily occupy the same memory space.

Unlike other linkers, the overlay manager acts on its own, needing no calls from the source program. Instead, Plink86's straightforward overlay description language allows you to describe your overlay structure in one place in your program — a structure permitting up to 4,095 overlays stacked 32 deep. No recompiling to re-arrange the structure!

Plink86 can even sub-divide its linked output into multiple files for programs which must span more than one disk.

PC Tech Journal calls it "the premier linker and overlay loader that's taking over at many of the programming shops around the country."

Product Code: S0500 # — Our Price:
List Price: **$395.00** — **$315.00**

LATTICE C COMPILER

Over 25,000 Users Make it the Best Seller by Far

Lattice C has been the standard-bearer compiler for years. Peter Norton in *PC Magazine* (1/8/85) said, "best for systems programming. . .tight code. . .total control of what's going on. . .noticeably better than any of its competitors". After reviewing nine compilers for the PC, the *PC Tech Journal* unequivocally declared Lattice C "best for software development. . .it compiles fast and produces fast programs."

When Lattice C appeared, there was nothing comparable. Ever since, software developers have created exceptional tools and function libraries to marry into Lattice C. Programmers now have an enormous resource of libraries and utilities intended for Lattice C to speed their work. That's a vital consideration in choosing a compiler. Better check whether the latest geewhiz may have only gewgaws to go with it.

Lattice C runs on virtually any computer using an 8088 or 8086 chip, and generates code which optimizes use of the 8087 chip, if present. Create your source files with any word processor or text editor and Lattice C will compile them into Intel 8086 object module format for linking to other modules by DOS's Link or our Plink86.

Lattice C offers a choice of four memory modules between 64K and RAM capacity for program and data to allow you to choose the right combination of small memory efficiency and large memory addressability. It is a full implementation of Kernighan and Ritchie (K&R), with 39 character variable names, nested comments, transcendental and Unix math functions K&R didn't think to mention, and some of Unix's most useful options such as "fork", to pull a second program into memory alongside the first, branch to it, and return.

Product Code: S0100 # — Our Price:
List Price: **$500.00** — **$295.00**

CDEBUGGER NEW!

A Source Level Debugger!

We've offered "symbolic" debuggers for some time. They can refer to program symbols — the names you give to variables, functions, etc. in your source programs — so you don't have to debug C programs by way of hex memory addresses. Now along comes a true source level debugger for programs compiled with Lattice — and at a breakthrough price.

Switch on the Cdebugger™ source display, from the beginning or at any breakpoint, and enjoy the uncanny experience of watching your source code step by, one line at a time. Or skip ahead n lines and display from there. Or browse through source from the surrounding program area — even from another file.

Multiple breakpoints can be assigned to individual lines in your source files. Areas of memory can be set read-only to let a form of write protection help find the most elusive bugs, like pointer encroachment. Trace options allow display of function names and line numbers as executed. Backtrace writes a history of all functions called, a dandy roadmap of how you got lost.

Other commands display and alter memory and registers, show and replace expression values. Simple variables may be referenced directly by name. (Not local names which the compiler doesn't map.)

No list of source files need be provided to Cdebugger. It simply targets all .c files in the current directory. Cdebugger supports and automatically recognizes all four memory models. Needs 256K.

Product Code: S1100 — Our Price:
List Price: **$165.00** — **$135.00**

Special Price: Lattice C and Cdebugger combined: **$395.00**

RUN/C

A C Interpreter at Last — And it Works like BASIC!

C is contemplative, elegant. But even elitists yearn (silently) for the simpler days of throwing together code with the instant interaction of an interpreter.

The good old days are here again. We have not just a C interpreter, but one that acts like BASIC! Use RUN/C's in-line editor to create a program. RUN it, just like BASIC. If it stumbles, just LIST it, EDIT it, add lines, delete lines, RUN it again, fix it again. The simple luxury of break key interrupt is restored, and RUN/C™ even has TRON, TRACE, and a profiler which reports the number of times each program line is executed.

RUN/C's "editor" command will save a program and automatically hand it to your favorite editor for further work. Or you can use its "shell" command to summon your compiler from *within* RUN/C.

For the professional, RUN/C is ideal for rapid program development. Put up code at high speed, tinker and re-arrange, throw in test printouts, bang away at tight little sections until they're bullet proof — *then* hand them to the compiler.

RUN/C has a treasury of functions built into the interpreter — over 100 paralleling the most used functions found in standard compiler libraries. Only programs calling other functions or other libraries for which you do not have source need special measures (e.g., comment-out, dummy functions). Well worth it to win the productivity gains of an interpreter.

Your disk supplies a separate source code file demonstrating each of RUN/C's library functions, with a manual to match. In fact, if you are new to C, this product doubles as a superb tutorial! (Requires 256K, DOS 2.x).

Product Code: S0900 # — Our Price:
List Price: **$150.00** — **$129.00**

Special Prices: Lattice C and RUN/C combined **$395.00**
RUN/C, BASIC_C, and Bastoc **$495.00**

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Compatibility: PC BRAND's standard products are designed to operate with the IBM PC, XT or AT under PC-DOS and require no more than 128K of RAM unless indicated.

Returns: Products returned will be accepted for refund or credit only by prior authorization subject to a re-stocking charge. Software diskettes are delivered in sealed envelopes and are unreturnable if seal is broken. Defective products will be replaced in whole or part.

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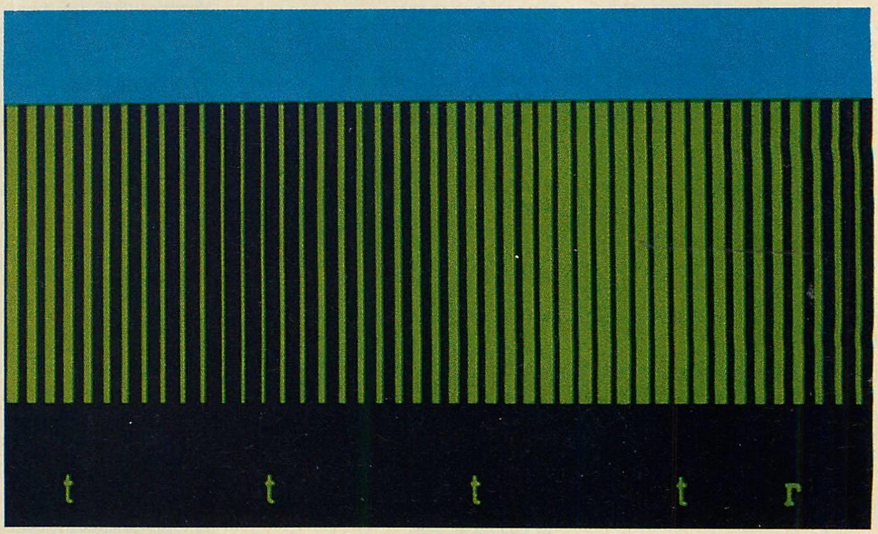
CIRCLE NO. 171 ON READER SERVICE CARD

PC/IX

IBM's version of UNIX for the PC has power, speed, and a wide range of programming tools.

AUGIE HANSEN



PHOTOGRAPHS • STEVE BORNS

The first microcomputer UNIX system to carry the IBM label is a simple, but solid implementation for the PC family. PC/IX (for Interactive Executive) was ported to the 8088 microprocessor from AT&T System III sources by Interactive Systems, a vendor that has provided mainframe software to IBM for a long time. The original release of the product (1.0) has been available for more than a year, and the 1.1 update was delivered in March of this year. The newer release includes updated versions of many applications programs and standard utilities in addition to the updated UNIX kernel.

Version 1.0 of PC/IX runs on a PC equipped with a fixed-disk expansion unit, on a PC/XT, and on a PC/XT-370. The recently released PC/IX version 1.1 runs on those same machines and on the PC/AT in real-address mode only.

This multitasking, single-user UNIX product for the PC famiy is a nearly complete System III implementation. Only a few programs (the **cu** program, some language support) are omitted. (For details, see "Reflections on UNIX," Augie Hansen, *PC Tech Journal*, May 1985, page 54, which presents a summary of the major commands and applications supported by PC/IX and five other UNIX and UNIX-like products.)

The full-screen editor **INed** is supplied with PC/IX (see sidebar). The well-known **vi** screen editor is not available under PC/IX. It cannot be considered missing, however, because it was not adopted by AT&T as a standard UNIX program until System V, although it has been available for many years as a nonsupported program. PC/IX has the **curses** screen-management library functions and the **termcap** database that were developed to handle the virtual terminal interface for **vi**.

The PC/IX 1.1 package contains 19 diskettes. For those who already have PC/IX 1.0, a 1.1 upgrade kit is available for $40. This kit contains five diskettes: a replacement for the original maintenance diskette plus four update diskettes. Anyone ordering the upgrade kit for a PC/IX system must ship the original maintenance diskette with the order as proof of purchase.

PC/IX is sold as one complete package that consists of a core system and seven subsets—programming, communications, SCCS, text processing, special-purpose programs, games, and system accounting. Although the package is partitioned into logical groups of functions, only the core system, consisting of eight diskettes, must be installed. All subsets are optional. The programming subset occupies four diskettes. The remaining subsets occupy one diskette each; in addition, a maintenance diskette is supplied for installing PC/IX.

The C compiler produces only *small*-model programs, permitting processes to have up to 64KB each of code and data. The default is a single 64KB allocation for both text and data. PC/IX contains no compilers for FORTRAN, Pascal, or BASIC, but it does include several SNOBOL dialects (the **bs** compiler/interpreter for a blending of BASIC, SNOBOL4, and C; and **sno**, a standard SNOBOL interpreter).

The Bourne shell is the sole user-interface program. Program and text editing is done with **ed**, the standard UNIX line editor, and by **INed**, the full-screen editor provided by Interactive Systems. Interactions with PC-DOS files are handled by a set of diskette-interface routines that permit the programmer to list, read from, and write to DOS files under PC/IX.

To prevent possibly destructive simultaneous access to files, PC/IX uses a record-locking scheme that provides exclusive use of designated regions of a file to the locking process. If another process attempts to read from, write to, or lock the locked region, that process will "sleep" until the region is unlocked. If deadlock would result from this sleeping, the **lockf()**, **read()**, and **write()** functions return an error code in lieu of waiting for a locked region. Buffered I/O functions cannot be used on files that will contain locked regions (there goes the standard I/O library).

SYSTEM REQUIREMENTS

Table 1 summarizes PC/IX's hardware requirements and support for optional hardware. PC/IX supports the IBM line of personal computers except for the PC-3270 and the discontinued PC*jr*.

On the AT, three drives may be installed—two fixed and one floppy or two floppy and one fixed. The second floppy disk can be either the 360KB or the 1.2MB drive. Although two serial ports are recommended on the AT, additional interrupt vectors are available, permitting up to eight serial ports with appropriate third-party hardware.

On color graphics display systems, limited graphics support is available for both the XT and PC. All other configurations support only text mode when using the color display. If both monochrome and color display adapters are installed, the **stty** command can be used to switch between them.

Expansion memory and additional disks (fixed and floppy) up to the limits of the host machine may be used in an installation to provide improved system performance and increased user file capacity. The notes in table 1 describe anomalous conditions associated with some hardware configurations. For example, PC/IX cannot read the date and time from the battery-operated clocks found on many multifunction boards; the date and time must be set manually each time the system is booted.

The maintenance diskette has a stand-alone shell and support programs that bring PC/IX to life. PC/IX can be installed on a fixed disk that contains another operating system as long as there is room for a partition of at least 100 cylinders—which will provide enough memory for the core system only. Larger allocations are needed to accommodate optional PC/IX subsets.

On an XT fixed disk, each cylinder contains 68 blocks of 512KB each. Some blocks will be reserved for PC/IX bootstraps; some are reserved for alternate blocks when any bad blocks are found by the media-check function during formatting; and still others are allocated for swapping of processes. To ensure the best system performance and adequate space for users' files, the entire disk should be set aside for PC/IX. An AT with a 20MB fixed disk will be able to store both PC/IX and DOS or some other operating system. Of course, user applications that manage large data sets will require correspondingly large disk-space allocations.

The installation procedure for version 1.1 of PC/IX is spelled out in the *System Manager's Guide*. A PC/IX installation update summary (consisting of two pages) is provided with the 1.1 upgrade package. Although the exact procedure varies with the target machine and the version of PC/IX being installed, it involves three general steps: partitioning the fixed disk, installing the core system, and installing the desired optional subsets.

To upgrade from PC/IX version 1.0 to 1.1, the core system and applications subsets must be installed before their respective updates are applied. The core programs are loaded by an installation program on the maintenance diskette. The 1.0 subsets are copied from the diskette using the **restore** command, and the updates are applied using the **/tmp/update** command that is supplied with the upgrade kit. Version 1.1 update files overwrite earlier versions of the same files.

To avoid lost time and wasted effort when installing PC/IX 1.1 the user should be sure to stop after step 24 of the instructions for installing version 1.0—that is, after the core system has been installed. It is easy to forget that

TABLE 1: *Hardware Requirements*

MINIMUM CONFIGURATION	
System unit (second fixed disk optional)	PC/XT
	PC with 10MB fixed-disk expansion
	PC/AT with 20MB fixed disk
	IBM XT/370 with 10MB fixed disk
Memory	256KB (expandable to 640KB)
Diskette units	1 DS (expandable to 4)
Display/adapter	Monochrome or color
Serial port	1 (expandable to 2)
OPTIONS	
Math coprocessor	8087 or 80287
Printers	Up to two IBM Graphics, IBM 80 CPS Matrix, or IBM Color printers

With the release of version 1.1, IBM's PC/IX can be run on an AT in real-address mode only, with a 640KB maximum address space.

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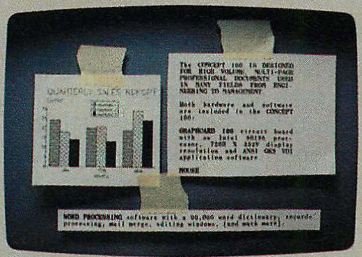

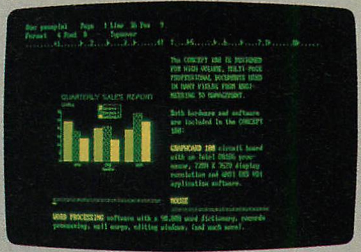

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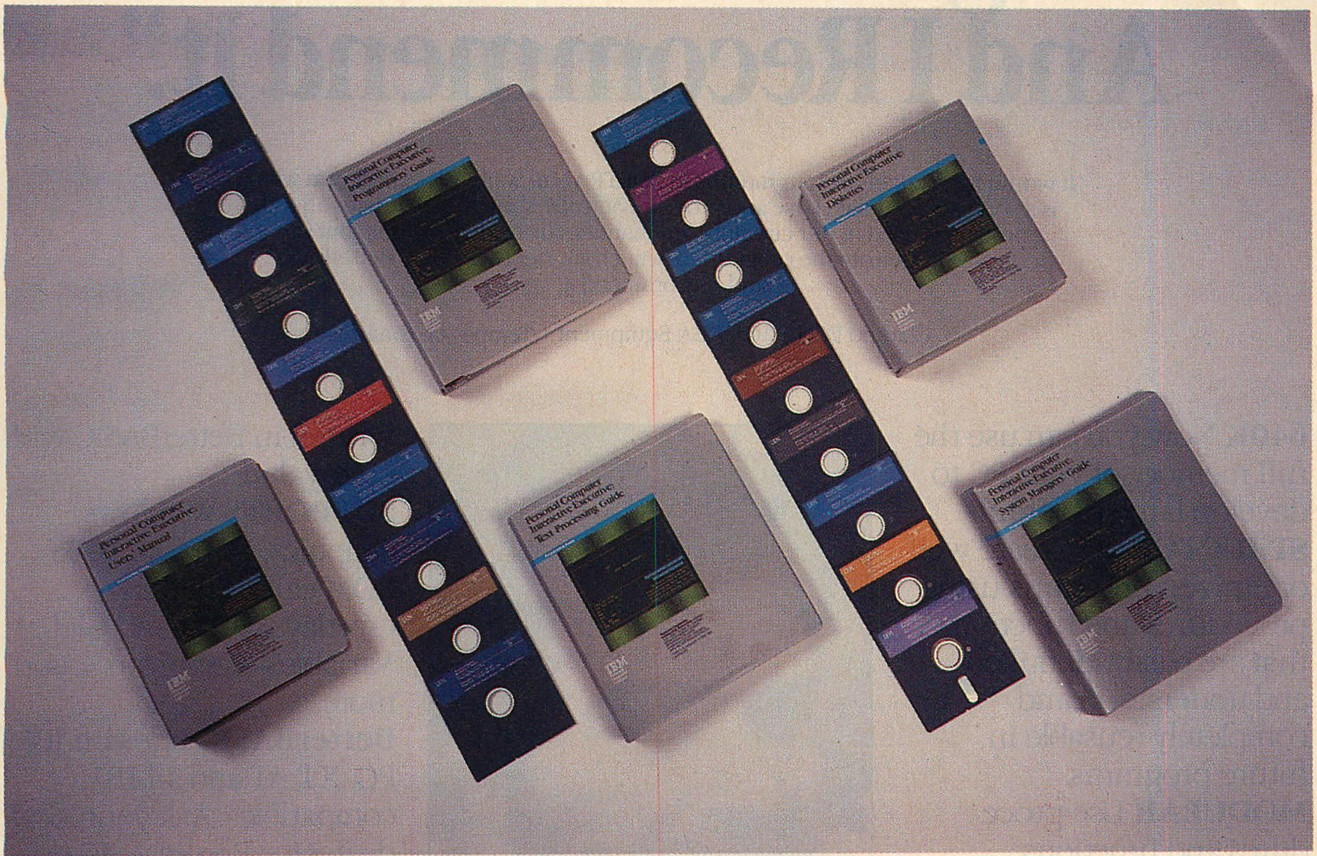
PHOTO 1: *PC/IX Documentation*



Most of the material in the manuals for PC/IX is reproduced verbatim from the original AT&T memos and manuals.

the update instructions say to do only steps 1 through 24. In addition, be sure to use the **sync** command immediately after installing any optional subsets in order to guarantee that all disk buffers are flushed before proceeding with other installation steps. Failure to do so results in a corrupted file system, and an uncharted recovery procedure is necessary before proceeding to first log-in.

The installation process takes about 30 minutes for the PC/IX system (the core plus all subsets) and another 5 minutes to run the update programs.

When PC/IX was first introduced, many people were disappointed that it was designed to be a single-user system, thereby depriving users of one of the touted features of UNIX. In retrospect, it may have been a smart move by IBM. The 8088 bogs down badly under load, and multiuser operations require extra system overhead. (On faster machines, such as the Compaq DeskPro and the AT&T PC6300, speed is not as much of an issue.)

The AT is another story. PC/IX for the AT could easily be redesigned for multiuser operation, because both raw speed and memory protection are available. However, IBM's XENIX for the AT is now being delivered (a review will appear in a future issue of *PC Tech Journal*), and IBM reportedly has suppliers working on UNIX System V multiuser ports for the AT and other computers in its lines. Many people speculate that PC/IX will also be moving to system V in the next year or two.

User access to PC/IX is via the PC console or through a serial port from a remote terminal. Remote-screen editing is not supported because **INed** is designed to interface only with the PC console keyboard and screen; it cannot be used remotely. This means that all editing from a remote terminal must be done with the line editor, **ed**.

At least one enterprising company has moved to fill this hole in the PC/IX system. Emerging Technology Consultants has rewritten its Professional Writers Package, which includes EDIX, WORDIX, SPELLIX, and INDIX, in C (the package used to be written in Pascal) and has produced object modules that will run under various licensed UNIX systems. EDIX, the full-screen editor, can be run from a remote terminal. Except for a few cosmetic changes, the PC/IX version of EDIX is the same editor that functions under DOS. It uses a slightly altered command syntax, because few terminals have an Alt key, but on the PC console, the commands can be mapped to match those used in the DOS version. Emerging Technology Consultants makes these products available through OEM channels rather than through the dealers and distributors who handle its PC-DOS and MS-DOS products.

DOS INTERFACE

Most PC UNIX packages provide a way to access DOS disks, and PC/IX is no exception. It has four primary interface programs, which are described briefly in table 2. All of these programs can work with files on disks and fixed-disk partitions that are formatted for PC-DOS and accessible to PC/IX. All of them also have a verbose mode that displays disk format information.

Each of the commands can be accompanied by options (indicated as "[opts]" in the table)—the option **-v** forces the system to use verbose interaction, the option **-m** asks the system to search a fixed disk for a DOS partition, and the option **-d** is used to specify a particular device. The commands cannot be linked to other names. They do not attach special meaning to wildcard

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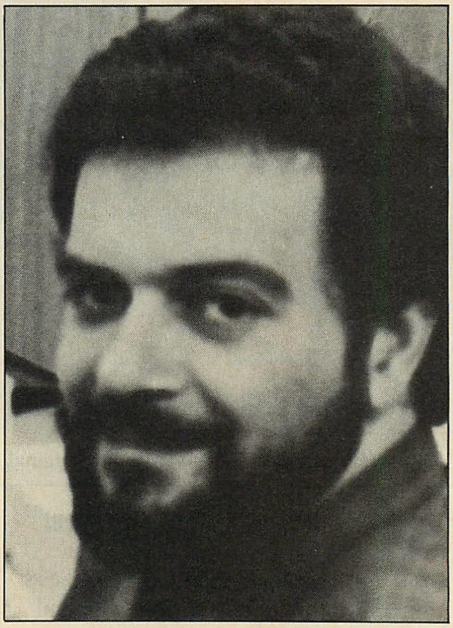

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characters, although the shell does. An unspecified DOS file-name extension matches any number of blanks, including no blanks.

The **dosdir** program emulates the **ls** type of directory listing and uses DOS file-naming conventions, except that a forward slash (/) is used instead of the backward slash (\) used by DOS to separate components of a path name. Also, **dosdir** shows file size and attributes (archive, directory, hidden, read-only, and system) and has a special option, **-e**, that produces "excruciating" detail about each file when used in tandem with the **-l** option for a long listing. The added detail is a list of diskette clusters occupied by each file.

The PC/IX equivalent of the DOS ERASE (or DEL) command is **dosdel**. It behaves in a predictable way under most circumstances, but it uses only the first match (in directory order) of an ambiguous file name. Because the DOS interface programs are designed for one-file-at-a-time use, this is not unexpected behavior, but it is counter to the generally consistent use of the UNIX shell's expansion of file names.

The **dosread** and **doswrite** programs are not as flexible as the **doscp** program supplied with XENIX, but they have one clear advantage—they work correctly with all current versions of DOS and any fixed or floppy disks in those formats. The **dosread** program copies one file at a time from a DOS disk to a specified PC/IX file or to the standard output if no receiving file is named. The **doswrite** program does the opposite, except that if no PC/IX file is named, input is gathered from the keyboard (unless redirected).

Both of the **dosread** and **doswrite** programs have an ASCII option, **-a**, that causes character conversions for line termination and end of file to be made. For **dosread**, the program converts carriage return/line feed indicators (CR/LF) to new line indicators (NL) and interprets Ctrl-Zs as EOF indicators. For **doswrite**, a new line indicator is converted to a CR/LF pair and a Ctrl-Z is inserted to mark the end-of-file position according to DOS specifications.

PC/IX does not provide support for executing DOS programs under PC/IX. This gap can be filled by The Connector, from Uniform Software Systems. The Connector is a DOS-emulation program that runs under PC/IX as a task. It permits easy interactions between PC/IX and DOS programs and integrates well with IBM's TopView.

For communications, the **cu** (for call UNIX) program is not available with PC/IX. Instead, IBM provides **connect**, which makes the calling PC/IX system look like a dumb terminal to the host system that it calls. A set of commands that are recognized by **connect** permits rudimentary file transfers and allows PC/IX commands to be run on the local system in a subshell. The communications parameters for the connection are stored in a file called CONNECT.CON. A user can specify a custom set of parameters in a private version of the CONNECT.CON file.

An add-on communications and networking package, available from IBM, includes **INmail**, **INnet**, and **FTP** (Feature Code 9217). The package is tightly integrated with the **INed** screen editor to provide electronic mail, protocol file transfers, networking, and remote printing capabilities.

TABLE 2: *DOS-PC/IX Interface Commands*

COMMAND	DESCRIPTION
dosdir [opts] [DOSfile]	Produce information about the named file, or for a directory, a listing of files
dosread [opts] DOSfile [PC/IXfile]	Read a DOS file to standard output or to a specified PC/IX file
doswrite [opts] [PC/IXfile] DOSfile	Write the standard input or a specified file to a DOS file
dosdel [opts] DOSfile	Remove a file from a DOS disk

PC/IX supports import and export of data in PC-DOS files on both floppy and fixed disks, but not execution of DOS programs.

TABLE 3: *PC/IX Benchmarks on the PC/XT*

C COMPILER			
PROGRAM SIZE (bytes)	**SOURCE**	**OBJECT**	**EXECUTABLE**
empty	11	136	186
sieve	663	456	274
hello	77	210	3370
COMPILE TIME (seconds)	**REAL**		
empty	0:09		
sieve	0:10		
hello	0:09		
EXECUTION TIME (seconds)	**REAL**	**USER**	**SYSTEM**
empty	0.2	0.0	0.0
sieve	2.3	2.2	0.0
hello	0.2	0.0	0.1

MULTIPROCESSING TESTS (minutes:seconds)	
FOREGROUND SEQUENTIAL	**REAL**
make sortdemo	0:20
make xsort	0:14
Total elapsed time	0:34
BACKGROUND/FOREGROUND	
(make sortdemo; echo "\07") &	0:30
make xsort	0:26
Total elapsed time	0:30
BACKGROUND "SIMULTANEOUS"	
(make sortdemo; echo "\07 1") &	0:34
(make xsort; echo "\07 2") &	0:25
Total elapsed time	0:34

The PC/IX C compiler produces tighter, faster running programs in half the time of the CMERGE compiler used under XENIX.

GOOD TO EXCELLENT

Testing of PC/IX for this article was done on several machines. Versions 1.0 and 1.1 were run on an XT with 576KB

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THE INED SCREEN EDITOR

Learning to use a text editor is always a big commitment in time and energy. I grudgingly learned **INed** only because no other screen editor is provided with PC/IX. It was easy to find things "wrong" with **INed** because I am accustomed to the way **vi** and **emacs** perform.

Having stated this weighty bias, I admit to being pleasantly surprised by **INed**'s capabilities and performance. A few of its idiosyncracies are hard to adjust to, but on balance it is quite a good editor.

INed is a full-featured screen editor with some formatting capabilities added to permit a basic level of text processing. Some of the primary **INed** features are described below.

On-screen formatting. **INed**'s options include paragraph fill, right justification, and on-line filtering of portions of the editing buffer through PC/IX and custom filter programs.

Cut and paste. Blocks of text may be copied or moved within a single file and between files. Blocks may be either rectangular areas defined by a "box-mark" command or arbitrary regions defined by a "text-mark."

Search/search and replace. This features searches forward or backward for literal strings of text (no ambiguous characters permitted). An optional replace command substitutes a typed string for the most recently found match to a search.

Global search and replace. Using an external program called **rpl**, the **INed** screen editor permits global replacement of a regular expression (wildcard characters permitted) search string with a second string.

"Structured" files. **INed** has built-in commands to manage structured files, keeping a record of changes to the file along with the contents of the file itself. A half-dozen PC/IX commands are designed to manipulate structured files from the shell.

Multiple editing windows. **INed** permits one or more files to be edited by using windows on the screen. A fine-line border delineates each window; the default window comprises an area of 20 lines by 78 columns. A "ruler" occupies the top line of the screen, and a status area takes up the bottom two lines. Cursor position, editing mode, and file name for the active window are reported in the status area at all times.

Menu interfaces. **INed** has an unobtrusive menu system that simplifies interaction with the shell and guides users through other operations available in the editor. Both system and local menus can be used, and they may be customized.

Flexible help system. The help system is complete and provides meaningful help that is context-sensitive. Whenever an error is detected, only the CANCEL and HELP commands are enabled, so it is usually easy to find out what went wrong and correct the problem.

INed is invoked using **e**; the general form of the command is

```
e [filename] [line] [col]
  [searchkey]<CR>
```

where the brackets are not typed but indicate that the enclosed item is optional. The **filename** may be any valid PC/IX relative or full path name: **line** and **col** specify a position in the file where the cursor should be placed; and **searchkey** is a string for which **INed** should search, starting at the specified cursor position.

INed uses the **$HOME/.estate** file to restore the previous editing state if it is invoked without a file name (**e<CR>**). The previous actively edited file is automatically loaded in such a case, and editing continues at the point where the previous session was terminated.

The editor has almost "modeless" operation, which means that without any special commands to alter the mode of the editor, typed characters may be inserted into the editing buffer and the cursor (editing pointer) may be positioned. Special operations do require switching to other modes, but normal text creation is analogous to typing on a standard typewriter. Because of the way in which **INed** is implemented, it treats the Return key specially. Instead of terminating the current line and opening a new line, it simply moves the cursor to the beginning of the next line, scrolling a line if necessary. Special mode switching is needed to insert one or more blank lines in the editing buffer—a somewhat unnatural practice.

The default text mode is insert, but overtype mode can be selected. Cursor positioning uses the arrow keys, and other commands are formed using Alt key combinations. It is unfortunate that no commands to move forward and backward word by word are included. The best approximation of this motion is provided by using the Tab key to move forward and backward in larger units and the arrow keys for local motions, which is a bit awkward.

The **INed** editor is highly configurable, both at a generic system level and on an individual user level. The configuration files **/etc/eprofile** and **$HOME/.eprofile** are used to tell **INed** how to behave in a variety of circumstances. These are structured files that contain various forms and pointers to directories and files that are used to perform tasks ranging from setting colors for the display to delivering prepackaged forms and help messages.

The help and error messages provided by **INed** are civilized. For example, they say "touch a key" rather than the brutal "Hit a key" of **vi** and so many other programs. **INed** is helpful and gracious in another way, too. It has excellent back-up and recovery features that make it easy to recover from system failures and self-inflicted disasters. The cost is a bit more but the security obtained is undoubtedly worth it.

—AH

---

of RAM (the converted PC that was described in the article "The Making of an XT," Augie Hansen, *PC Tech Journal*, March 1985, p. 161). Version 1.1 was also run on an AT with a CDC 20MB disk, from CORE International, and 3.2MB of RAM, of which PC/IX sees only 640KB, and on an enhanced AT with 640KB of RAM and the IBM-installed CMI 20MB fixed-disk drive. The CORE/CDC drive has about a 5-percent faster average access time than the CMI drive (38.1 versus 40.2 milliseconds), so all figures here use the CMI drive results.

Tables 3 and 4 tell part of the performance story of PC/IX from the user's perspective. The tests are designed to show the speed and efficiency of the C compiler and the performance under a multitasking load. Tests were conducted with a single user logged on to the console as root.

Table 3 shows the performance benchmarks of PC/IX version 1.1 on a PC/XT. Table 4 is a look at AT performance for the same version of the operating system. The two tables provide an

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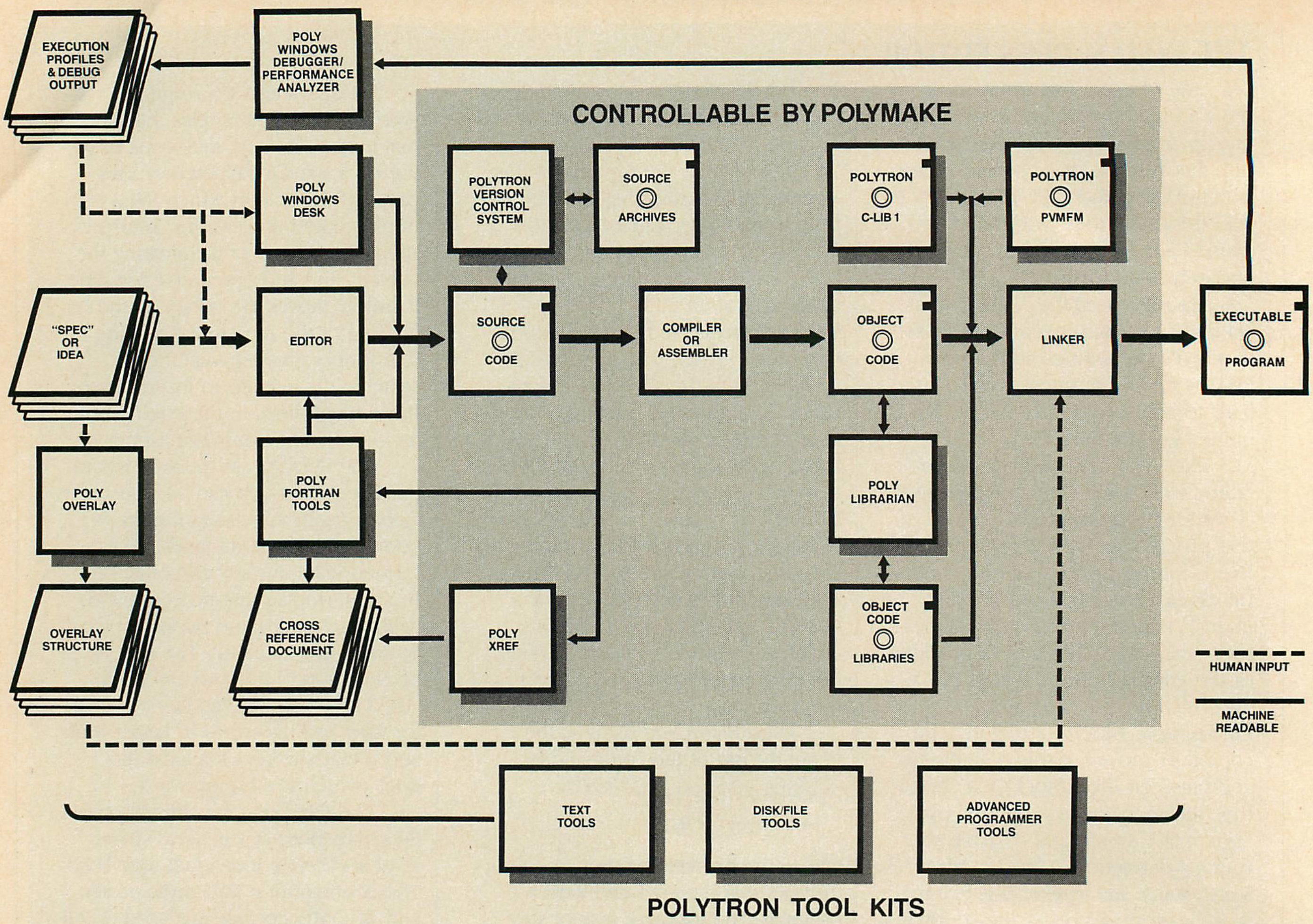

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interesting comparison between the AT and its older, less well-endowed sibling.

The source files that were compiled were a minimum-length C source file (called "empty" in the table), the well-known Hello World program (called "hello"), and Eratosthenes prime-number program (called "sieve"). **Sortdemo** and **xsort** are two small programs compiled in various combinations of foreground and background activity using the **make** utility.

The programs were compiled with the **-s** option, to strip the symbol table from the resulting object, and the **-o** option, to produce optimized code. The **cc** command removed the .o file after the link step was completed, so the size of .o files was obtained separately using the command line

```
cc -O -s -c file.c
```

after the full compile job was run using the command line

```
cc -O -s -o file file.c
```

PC/IX performance on an XT is significantly better than that of XENIX (see "XENIX for the XT," Augie Hansen, *PC Tech Journal*, June 1985, p. 129). PC/IX's C compiler produces tighter, faster running programs in about half the time that XENIX takes. Part of the compile-time improvement is the result of a limitation in capability—the compiler is simplified because it produces only small-model programs. The optimizer seems to do a good job of reducing unnecessary object code and choosing efficient assembly language statements. Note the small size (274 bytes) of the "sieve" executable program. The same program using the small model of the CMERGE compiler under XENIX is 2,096 bytes. The "Hello" program is about 25-percent smaller than its XENIX/CMERGE equivalent.

PC/IX on the AT puts in an excellent performance. PC/IX 1.1 runs in real-address mode on the AT, limiting it to the same maximum memory size as the earlier version on an XT—640KB of RAM. This mode still has no memory protection, so user programs could potentially clobber other running programs and even the operating system itself. Speed is the key benefit of this mode—PC/IX on an AT performs tasks three to four times faster than it does on a comparably equipped XT.

Five binders contain the documentation and diskettes that comprise the PC/IX 1.1 package. The *User's Manual* (in an 8½-by-10-inch binder) reproduces, almost verbatim, the traditional manual pages with which many UNIX users have long had a love-hate relationship. The only differences are the product name and accommodation of the single-user status of PC/IX. The three full-sized binders are the *System Manager's Guide*, the *Programmer's Guide*, and the *Text Processing Guide*, which correspond roughly to the program groups on diskette. In version 1.0, two of the large binders were too full to permit easy page turning; infrequently used information had to be moved to another binder to make for easier handling. The complete version 1.1 has thicker binders.

Most of the material in these manuals is reproduced with minor changes from the original AT&T memos and manuals. The **INed** editor, **connect**, and other non-UNIX features are covered in newly written documents with a style of writing and layout that is markedly different from the rest of the package. The keyboard template that describes the editing keys for **INed** is now two-sided, one side for the PC and XT keyboards and the other for the AT.

PC/IX is a solid, single-user UNIX system for the IBM PC family. No significant bugs were uncovered during testing. The multitasking capabilities, combined with the many tools for software and documentation development, are a joy to use. The excellent responsiveness exhibited by this operating system on the AT is something that must be experienced to be believed.

Now if IBM will provide a multiuser, protected-mode version of PC/IX that is based on System V UNIX—with the major Berkeley applications and a C compiler that can handle middle- and large-model programs—I won't ask for very much more.

PC/IX 1.1: $900
Upgrade package (from 1.0 to 1.1) $40
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Product Number: 1753369
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Augie Hansen, who spent seven years at AT&T and Bell Laboratories, is currently at work on a series of books about UNIX, to be published by Brady Communications. The author's net address is: {allegra,amd,attunix,cbosgd,ucbvax}!nbires!bdaemon!arb.

TABLE 4: *PC/IX Benchmarks on the PC/AT*

C COMPILER			
PROGRAM SIZE (bytes)	**SOURCE**	**OBJECT**	**EXECUTABLE**
empty	11	136	186
sieve	663	456	274
hello	77	210	3370
COMPILE TIME (seconds)	**REAL**		
empty	0:09		
sieve	0:10		
hello	0:09		
EXECUTION TIME (seconds)	**REAL**	**USER**	**SYSTEM**
empty	0.2	0.0	0.0
sieve	2.3	2.2	0.0
hello	0.2	0.0	0.1

MULTIPROCESSING TESTS (minutes:seconds)	
FOREGROUND SEQUENTIAL	**REAL**
make sortdemo	0:20
make xsort	0:14
Total elapsed time	0:34
BACKGROUND/FOREGROUND	
(make sortdemo; echo "\07") &	0:30
make xsort	0:26
Total elapsed time	0:30
BACKGROUND "SIMULTANEOUS"	
(make sortdemo; echo "\07 1") &	0:34
(make xsort; echo "\07 2") &	0:25
Total elapsed time	0:34

The excellent responsiveness of PC/IX on the AT is a joy to use with tasks running three to four times faster than they do on an XT.

Pocket APL

PARDNER WYNN

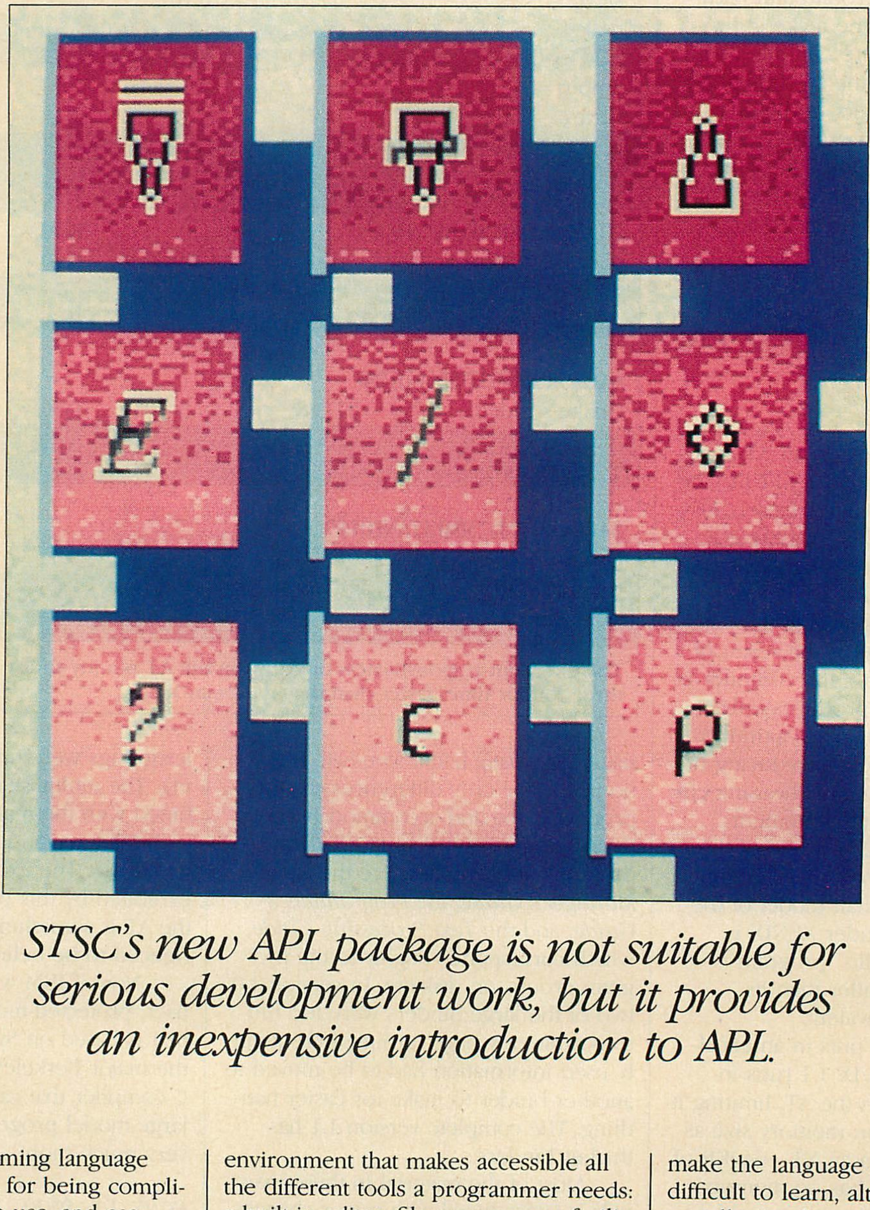


ILLUSTRATION • GARY ZAMCHICK/LEXICA

STSC's new APL package is not suitable for serious development work, but it provides an inexpensive introduction to APL.

The APL programming language has a reputation for being complicated, difficult to use, and esoteric—of use primarily to scientists and engineers who work with numbers a great deal. In truth, APL is a self-contained programming environment that is simple to use and valuable for a wide range of business, engineering, and educational applications. STSC's newest product, Pocket APL, may afford more programmers the opportunity to discover this language's versatility.

Philosophically, APL is "right" for PCs: it is a truly interactive workspace environment that makes accessible all the different tools a programmer needs: a built-in editor, file-management facilities, powerful numeric and text-handling capabilities, debugging tools, and, of course, the applications-oriented APL programming language.

In the past there have been three barriers to more widespread APL use: the apparent complexity of the language, the inconvenience caused by having to use a different symbol set, and the cost of the product.

APL's large number of built-in functions and its "symbolic shorthand" may make the language seem complex and difficult to learn, although its syntax is actually simple and intuitive. In APL a single greek-looking symbol may represent a complex operation such as "find the largest number in this arbitrary-sized list of numbers" or "take the inverse of this arbitary-sized matrix." That can be an intimidating prospect for a programmer who is used to writing self-documenting code.

APL uses a special symbol set that is different from the standard IBM ROM character sets. To accommodate this symbol set, an APL programmer gener-

ally must replace a ROM on his PC's display adapter with a special ROM that generates the APL-unique symbols. Although this replacement is not difficult, the effect is pervasive; the new characters are displayed even when APL is not in use. Many of the "normal" special symbols are replaced with APL symbols, so programs may display strange results after the new character ROM is in place.

In addition, it takes a while to become comfortable with the way the keyboard is redefined to include the special APL characters. For instance, the plus, minus, equal, and dollar signs are all moved to different locations on the keyboard, as are the bracket and parentheses symbols, the colon, the semicolon, the double quotation mark, the angle brackets, the single quotation mark, the question mark, and the backward slash. For example, the key marked ":" becomes "(". Most APL systems provide either transparent stickers for the keyboard or a reference card showing the new keyboard layout.

Cost has been the third deterrent to the widespread use of APL. STSC's APL-Plus for the IBM PC, which is widely considered one of the best APL packages for the PC, sells for $595. This would be quite an expensive purchase just to test the APL waters, and especially so in these days of excellent Pascal, C, and Forth compilers that cost between $50 and $200.

APL FOR THE MASSES

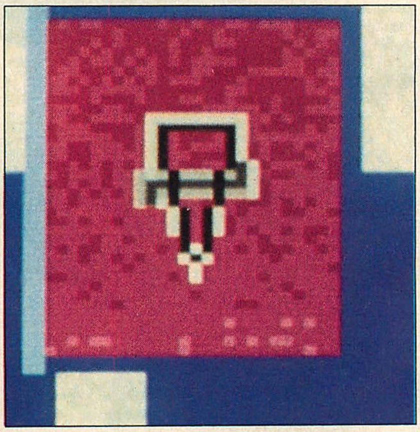
Many casual APL users would probably use the language for a variety of day-to-day tasks once they got started. An APL for the masses is needed.

IBM took a step in that direction last year with its $195 APL package for the PC, which has the useful feature of generating the special APL symbols with software, making a special ROM unnecessary. Unfortunately, IBM's package requires a math coprocessor chip, adding $230 to $375 to the price tag for people who do not already have an 8087.

Another advance toward an APL for the casual user has been made by STSC's Pocket APL. The package costs only $95. In addition to its moderate cost, Pocket APL requires no special ROM and gives the programmer the option of bypassing traditional APL symbols in favor of key words, such as **rotate**, **invert**, and **transpose**.

Pocket APL comes packaged in a 7-by-9-inch box that is about an inch thick and includes STSC's useful 175-page booklet *APL is Easy!* In addition, the package includes a 20-page *Pocket APL Reference Guide,* a 6-page *Installation Guide,* a cardboard keyboard placard showing which IBM key corresponds to each APL symbol, a key-word reference card, a warranty and license agreement and a registration card. The software, which includes demonstration programs and utilities, is all contained on one double-sided floppy disk.

According to STSC, the package should also include an errata sheet that



documents a few changes to the keyboard placard and a modified start-up procedure for AT users who do not have an 80287 math coprocessor. (My package included neither of these, but I was provided the start-up procedure over the telephone—because I used an AT without the 80287—and I was sent an errata sheet in the same day's mail.)

The documentation calls Pocket APL a scaled-down version of the APL-Plus system. A summary of its limitations and omissions as compared to APL-Plus is provided in table 1.

STSC states that Pocket APL will run on the IBM PC, XT, AT, and PC*jr*. Memory requirements, however, make it impractical for use on the PC*jr*. Although Pocket APL requires a minimum of only 128KB, at least 192KB is needed to use the 64KB maximum workspace that is allowed by the language. On a standard (128KB) PC*jr*, the maximum workspace size is less than 21KB.

For the topics it covers, the STSC documentation is well thought out and adequately indexed. *APL Is Easy!* is an excellent step-by-step guide to using APL. Unfortunately, the booklet was apparently written for STSC's APL-Plus product. It does not discuss several features that are particular to Pocket APL, such as function-key use, native (DOS) files, debugging facilities, printer support, extensions to the standard APL line editor, and the use of key words. Other features (such as overstriking characters) are mentioned in passing and not indexed for later reference. The booklet also incorrectly states that function key F1 is used for the help system, as it is APL-Plus; in Pocket APL, function key F6 is used.

APL Is Easy! provides numerous useful exercises and serves adequately as a guide to the use of most APL functions. For more detailed information, the *Reference Guide* is needed. It is a helpful summary of APL operators, system functions, editing functions, and display formatting. As mentioned above, however, many of the topics are poorly documented, if they are discussed at all.

It also should be noted that neither the *Reference Guide* nor *APL Is Easy!* can replace what has become known as the standard APL text: *APL: An Interactive Approach*, by Gilman and Rose. Anyone who plans to use APL should buy this easy-to-read tutorial.

THE SOFTWARE

The Pocket APL disk contains four files: APL.EXE, the APL system; SYSHELP.ASF, menus for the built-in help facility; DEMOAPL.AKS, the examples in *APL Is Easy!;* and *LESSONS.AWS,* a sample workspace with several demonstration programs, including a handy list program utility and a calendar utility, and a just-for-fun program that converts a sentence to "pig latin."

The disk files are not copy protected, so they can be transferred to another work disk. The four files occupy about 160KB; thus, Pocket APL is reasonably suitable for work with diskette-based systems. Of course, Pocket APL also supports hard disk drives.

Pocket APL is standard APL with enhancements. Two programs written in IBM APL ran in Pocket APL (and APL-Plus) with absolutely no changes. One of these programs was a Life game tutorial example (see "Life Is Simple with APL," Pardner Wynn, *PC Tech Journal*, September 1984, page 129) that used a wide range of matrix operations and data-formatting operations as well as a good deal of screen I/O. The second program was a TTL logic simulator that required a nominal amount of logic and data-swapping operations. Neither program required any nonstandard language extensions.

The Del editor. The lack of a real screen editor in Pocket APL is a substantial inconvenience. Although it is not documented, some elementary screen-oriented capabilities have been added to the Pocket APL Del editor, making it similar to the DOS BASIC line editor. These editor extensions allow the user to move the cursor freely around the screen and to make changes to existing

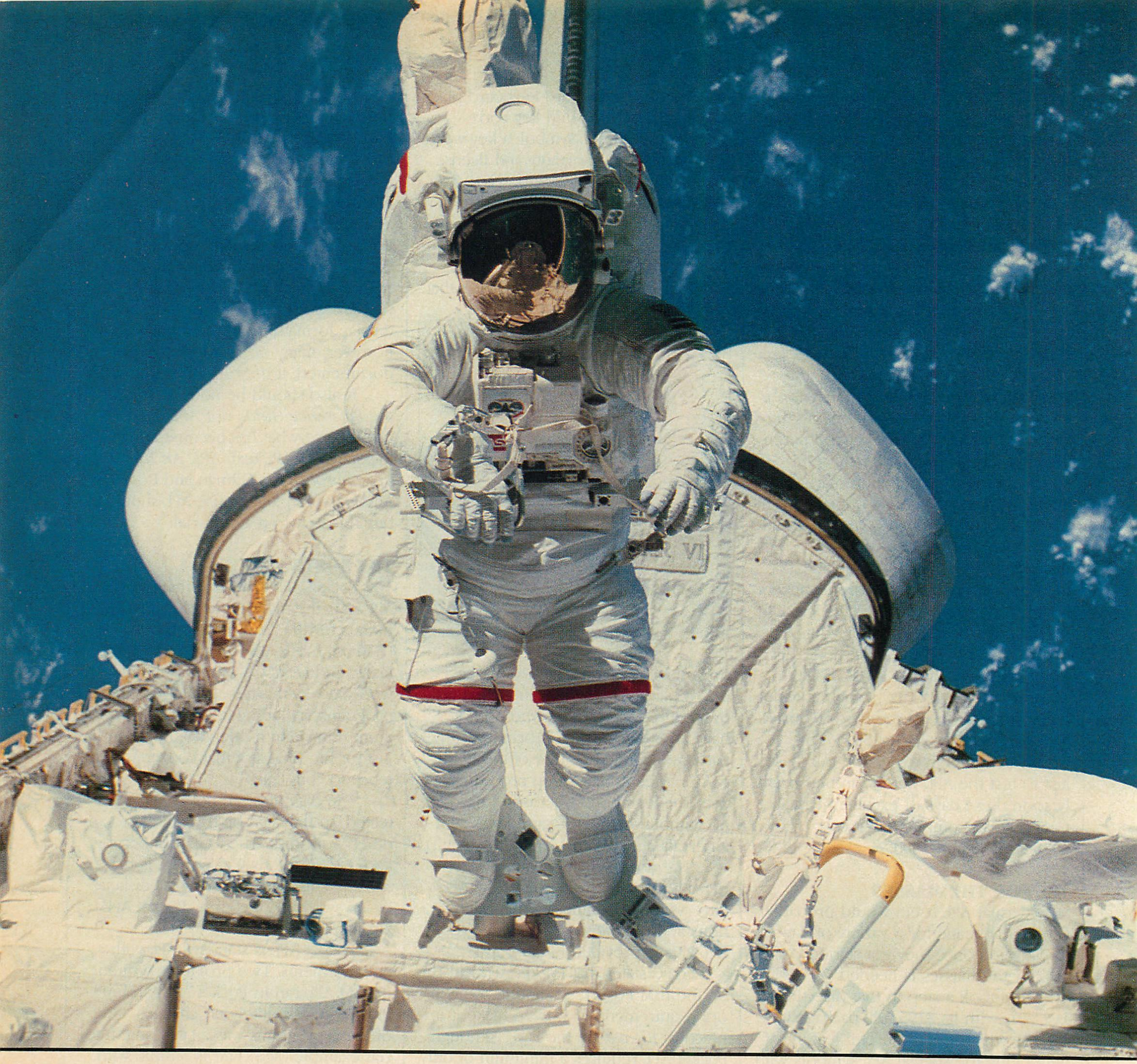


TABLE 1: *Features Comparison*

	POCKET APL	APL-PLUS	IBM APL
Price	$95	$595	$195
Screen editor	No	Yes	Yes
Maximum workspace size	64KB	(system memory)	64KB[1]
Component file size	10KB	(disk capacity)	64KB[2]
Communications support	No	Yes	Yes
Graphics	No	Yes	No
Interrupt handler	—[3]	Yes	Yes
Call DOS/BIOS routines	—[3]	Yes	Yes
Call assembly routines	—[3]	Yes	No
Sound generation	No	Yes	Yes
Execute DOS commands	No	Yes	No
Key words and symbols	Yes	Yes	No
Math coprocessor	Optional	Optional	Required

[1]*Excess system memory forms temporary "elastic" storage workspace*
[2]*Limited to 32KB components of 2KB maximum size*
[3]*Feature present or partially present, but undocumented*

For casual use or an introduction to the language, Pocket APL may be appropriate, but its limited features restrict its usefulness for serious program development.

TABLE 2: *Performance Benchmarks*

OPERATION	POCKET APL	APL-PLUS	RELATIVE SPEED
I is I+1	0.010	0.006	1.7
N is +/ VECTOR1[1]	0.128	0.042	3.1
N is −/ VECTOR1	0.129	0.044	2.9
N is downgrade VECTOR2[2]	0.380	0.377	1.0
N is invert MATRIX[3]	0.146	0.135	1.1
N is X lower inner + X[4]	0.024	0.019	1.2
TTL simulation	42.8	33.5	1.3

[1]*VECTOR1 is 0.25 times count 100*
[2]*VECTOR2 is 0.25 times count 1,000*
[3]*MATRIX is a 3-by-3 integer matrix; result N is 3-by-3 floating point matrix*
[4]*X is 4-by-4 integer matrix*

All times are in seconds. These benchmarks, run on an IBM PC/AT, show that Pocket APL compares favorably with APL-Plus in performance.

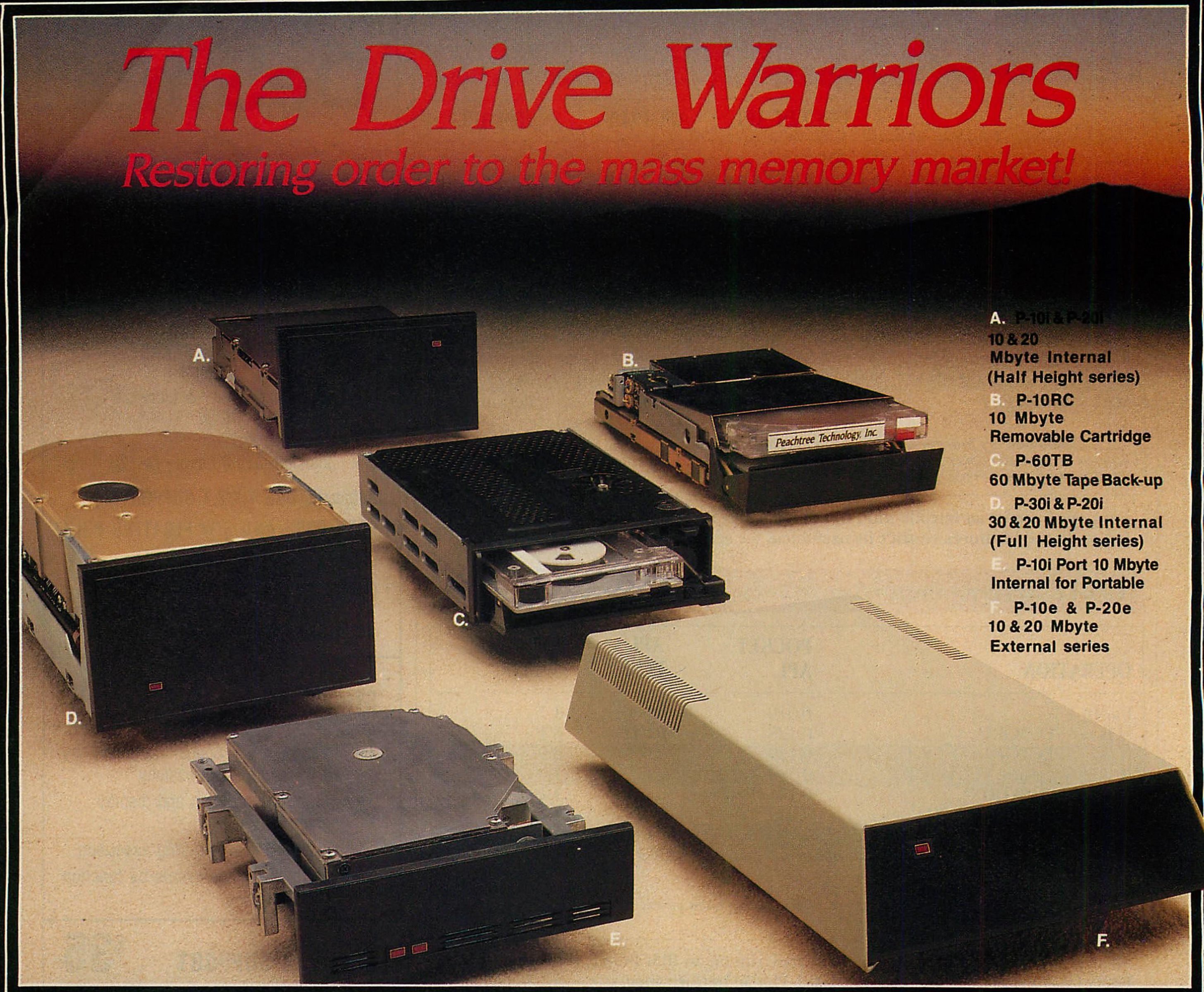
text. Although these extensions help, they do not fulfill the APL programmer's need for a full-featured screen editor. APL programming cannot accommodate just any text editor; the editor must "know" about APL and must work within the interactive APL environment.

Soft character set. STSC's newest APL releases (both Pocket APL and version 4.1 of APL-Plus) incorporate a software APL symbol generator that works with the IBM Color Graphics Adapter. Thus, Pocket APL can be used on PCs with an unmodified color graphics adapter or on PC*jr*s. The software-defined characters work only with the IBM Color Graphics Adapter (or with the PC*jr*), however, so users with a monochrome adapter must opt either to replace the character ROM or use key words instead of symbols.

Key words. Pocket APL can substitute key words for the traditional APL symbols. This feature serves two types of APL users—those who have monochrome adapters and would prefer not to replace the character ROM and those who simply prefer a nonsymbolic representation for APL operators. Figure 1 shows a sample APL program that has been listed in both symbolic and key-word form. The key words that correspond to each symbol are documented on the key-word reference card.

The user is free to switch from key words to symbols at any time. If he writes a program using key words and then switches to symbolic notation, the program will be converted to symbolic notation automatically when it is next loaded. When Pocket APL is started, the system allows the user to specify *S* for symbols or *K* for key words. Starting the system by typing *APL S* or *APL K* will bypass the query.

An interesting feature of key words involves symbols that are ambivalent (that is, symbols that can take on two



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different meanings, depending upon the context in which they are used). In this case, separate key words for each possible meaning, as well as one catch-all "ambivalent" key word, are provided for each such symbol.

For example, when the greek symbol phi appears in front of an array name, as in the expression "ϕA", it is a monadic (one argument) function, and the key word is **reverse**. When the phi appears between two quantities, as in "AϕB", it is a dyadic (two argument) function, and the key word is **rotate**. For further simplification, an ambivalent key word, phi, may be used. APL automatically determines whether the monadic or dyadic form is appropriate.

Help system. One nice feature of Pocket APL is its on-line help system, which covers a wide range of topics. Most of the information is menu-driven, and it covers a wide range of topics, from using the Pocket APL system to actual language syntax issues.

The help system does have one significant limitation, however. Information is given using symbols only. This can be confusing in key-word mode; because the soft character set is not loaded, the correct set of symbols is not displayed.

Floating-point support. Pocket APL does not require a math coprocessor for floating-point arithmetic. If an 8087 (or 80287, for AT users) is installed, Pocket APL will use it and therefore will handle calculations much faster. For everyday number-crunching requirements, software floating-point operation is fast enough, and it is much less expensive—math coprocessors currently cost between $230 and $375.

Screen I/0. STSC has added simple screen windowing operators to its product that are potentially useful extensions for applications programmers. This addition should simplify the development of easy-to-use data-entry and inquiry applications. For example, a pop-up help window would be fairly easy to code in Pocket APL as part of an inventory record-keeping system.

Printer support. Like IBM's APL, STSC's Pocket APL requires an IBM Graphics Printer (or compatible equipment) if printed listings of programs using APL symbols are desired. Using Pocket APL's optional key-word mode, reasonable printouts of programs can be obtained using printers that are not compatible with the IBM printer.

The documentation's index includes no entry under printing, but the *Reference Guide* describes how to use the POKE function to select the ASCII or GRAFTRAX printer mode. If the printer being used is not compatible with the IBM Graphics Printer, the ASCII (nongraphics) printer mode must be used. APL should then be used in the key-word mode.

The only documentation that describes how to print something is the errata sheet. Pressing Alt-F9 toggles on and off the feature that writes screen output to the printer. Pressing Alt-F7 prints the contents of the screen.

LIMITATIONS

Pocket APL is a cost-effective alternative for casual APL users. However, the system has several limitations and omissions. Whether these limitations are too restricting for a particular user will depend primarily upon the amount of data that will be handled and how much applications programming is done using the system.

Some of Pocket APL's limitations are probably concessions that are required of a system targeted at PCs with 128KB. Others are presumably designed to entice all but the most casual of users into buying STSC's other product, APL-Plus. (It should be noted that STSC has said it will send a $50 rebate cou-

pon to registered Pocket APL users who later upgrade to APL-Plus.)

Pocket APL is distributed with none of the useful utility workspaces that make APL-Plus a good development tool. In particular, it has no utility to read/write workspace files in a format compatible with IBM APL. Nor are there any utilities for communications and modem support. Graphics capabilities like those found in APL-Plus are also missing; these would have extended greatly Pocket APL's usefulness. A potentially worse problem for serious applications programmers is that although STSC claims that Pocket APL has facilities for accessing DOS function calls and BIOS interrupts, no such facilities are documented anywhere.

Most surprisingly, STSC did not include a full-screen editor with Pocket APL. Both IBM's $195 APL package and STSC's $595 APL-Plus include screen editors that greatly simplify program entry and modification.

The Pocket APL workspace size limits the amount of data and the number of programs and utilities that can be accessed at any one time. Although the product's 64KB maximum workspace is not so small as to put it in the toy category, it may impose restraints on the scope of applications for which the product can be used. More than likely, any serious business database management application is going to be too big for Pocket APL to handle comfortably. On the other hand, the product could be useful for the development of a business financial calculator, planning system, or simulation tool.

One of APL's nicest features is its use of component files, which are disk files that can contain a variety of APL objects, such as arrays of text, numbers, or matrices. Each object (or *component*) is referred to by its location within the file (component 1, 2, 3 . . .). APL manages space allocation for component files. For instance, a programmer can replace a 2-by-2 matrix component with a much larger 10-by-30 matrix without worrying about where the extra room will come from or how to keep from writing over other components.

Unfortunately, Pocket APL can handle only component files that are less

FIGURE 1: *Sample Programs*

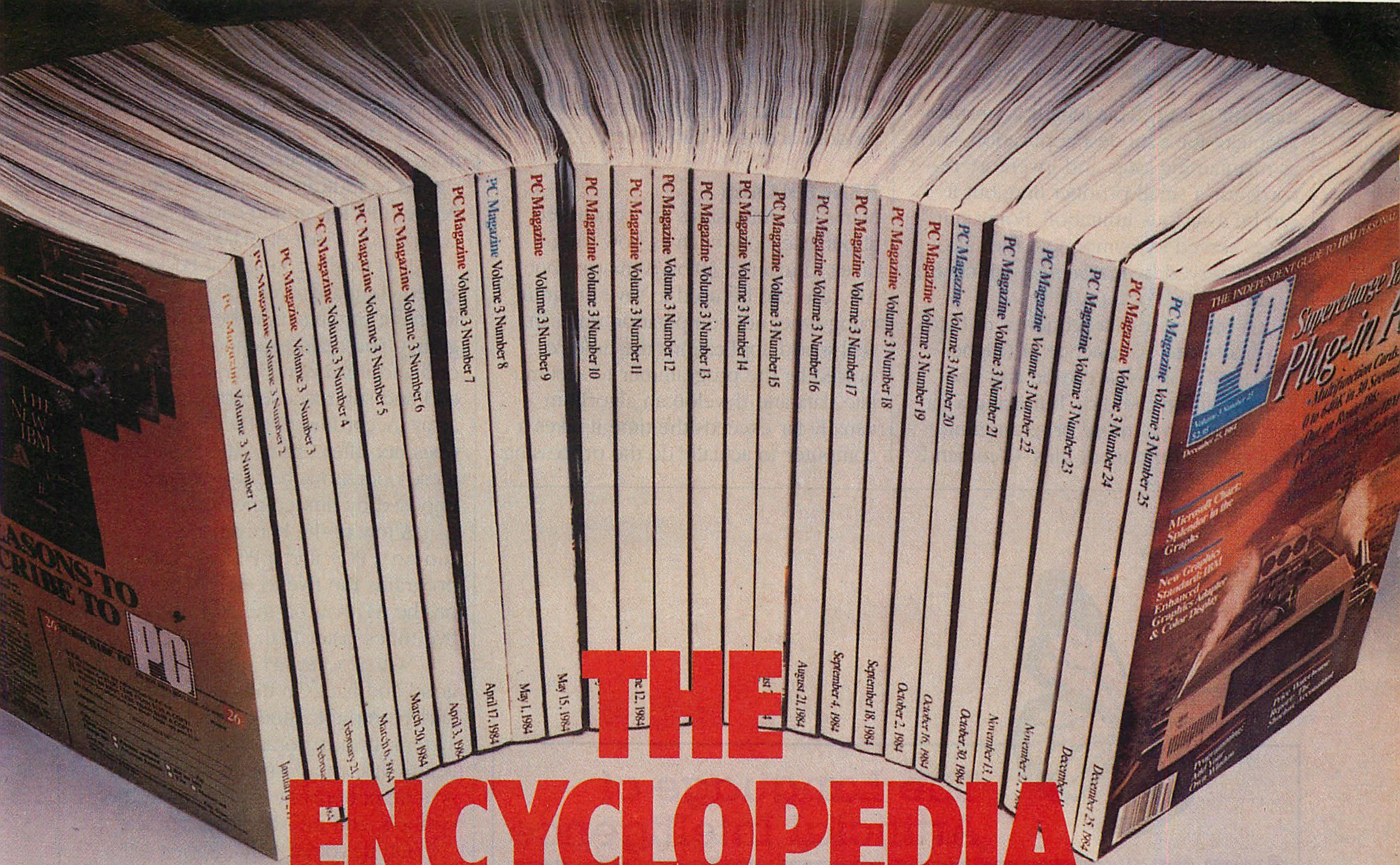
SYMBOLIC

```
     ∇LIFEGAME[⎕]∇
[0]  LIFEGAME
[1]   INITBORDER
[2]   COLONY←COLONY∧BORDERMASK
[3]   POPULATION←+/,COLONY
[4]   GENERATION←1
[5]  LOOP:→END×⍳POPULATION=0.
[6]   SHOWCOLONY
[7]   COLONY←NEXTGEN COLONY
[8]   GENERATION←GENERATION+1
[9]   COLONY←COLONY∧BORDERMASK
[10]  POPULATION←+/,COLONY
[11]  →LOOP
[12] END:⎕←'ALL ORGANISMS EXTINCT!'
[13]  ⎕←'Goodbye.'
```

KEY-WORD FORM

```
     $LIFEGAME[#]$
[0]  LIFEGAME
[1]   INITBORDER
[2]   COLONY is COLONY and BORDERMASK
[3]   POPULATION is+/,COLONY
[4]   GENERATION is 1
[5]  LOOP:goto END x iota POPULATION=0
[6]   SHOWCOLONY
[7]   COLONY is NEXTGEN COLONY
[8]   GENERATION is GENERATION+1
[9]   COLONY is COLONY and BORDERMASK
[10]  POPULATION is+/,COLONY
[11]  goto LOOP
[12] END:output 'ALL ORGANISMS EXTINCT!
[13]  output 'Goodbye.'
```

The first listing shows a sample program coded using traditional APL symbols; the second shows the same program using optional key words.



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than 10KB long. This length is probably adequate for a modest application, such as maintaining sales and inventory records for a small product line, but it can be a serious limitation. Some purposes served by component files also can be served by *native files*, which are supported by Pocket APL.

A native file is a sequence of bytes, as opposed to a sequence of (higher-level) APL objects. It can be any size that will fit on the disk, but using a native file involves more programming than using component files. Commands are provided for creation, deletion, and random access to native files.

BENCHMARKS

Many APL enthusiasts are concerned about questions such as how long it takes to invert a 30-by-30 matrix, but APL also can be used to save programming time, not computation time. In real-world applications the time required by the programmer to accumulate data and develop an algorithm usually far exceeds the time it takes a computer to actually do the processing.

Table 2 shows the times required to perform a variety of simple operations. All times were taken on an AT designed to indicate the performance of Pocket APL for simple data operations, compared to that of APL-Plus.

It is worth noting that Pocket APL's speed compares favorably with APL-Plus for most of the simple benchmark programs. The main exceptions are the second and third benchmarks listed, which add and subtract every element of an array. According to STSC, Pocket APL does not offer optimization routines for these operations because of constraints imposed by limited memory.

A few of the benchmarks also were run on a PC*jr* and a PC. As expected, programs ran five to eight times faster on the AT than on the PC*jr* and two to five times faster than on the PC.

With Pocket APL, the news is both good and bad. On the one hand, it is a fairly complete, moderately priced APL system. It incorporates several useful features, such as a menu-driven help system, optional key words instead of symbols, and the soft character set.

On the other hand, Pocket APL's utility is dampened by glaring omissions in otherwise useful documentation, the lack of a full-featured screen editor, and somewhat limited workspace and component file sizes. Although Pocket APL runs on a PC with 128KB of RAM, at least 192KB of RAM is needed for a 64KB workspace. On the PC*jr*, the maximum workspace size is less than 21KB—far too small to be put to any practical application.

Pocket APL is clearly not intended for serious development work. It can be recommended, however, for the programmer who is looking for a casual introduction to the APL programming environment and for those who need a language that would be appropriate for modest applications in the fields of business, education, and engineering.

REFERENCES

Berry et al. *APL and INSIGHT.* Palo Alto, CA: APL Press, 1978.

Gilman, Leonard, and Allen Rose. *APL: An Interactive Approach.* New York: John Wiley & Sons, 1983.

Pocket APL: $95
STSC
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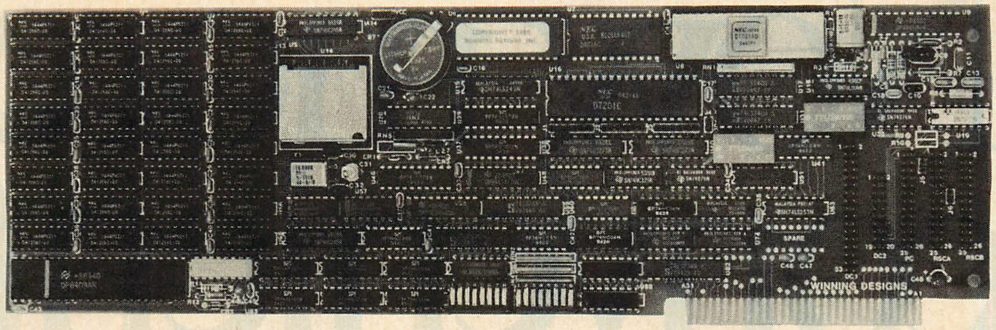
Rockville, MD 20852
301/984-5000
CIRCLE 305 ON READER SERVICE CARD

Pardner Wynn is an electronics and software engineer in Silicon Valley.



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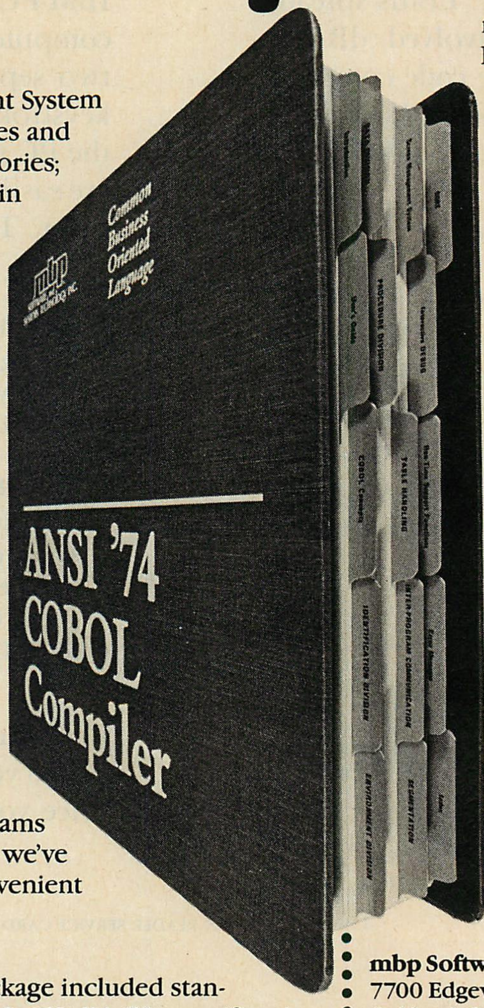

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Data Acquisition

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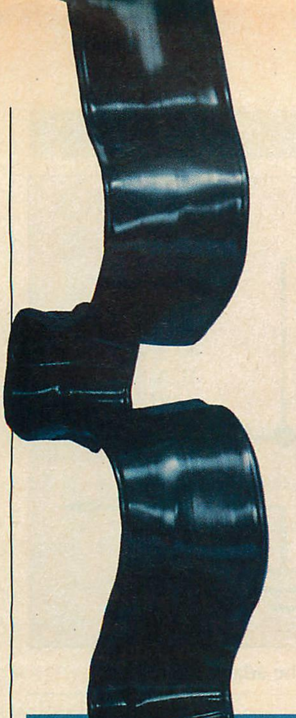
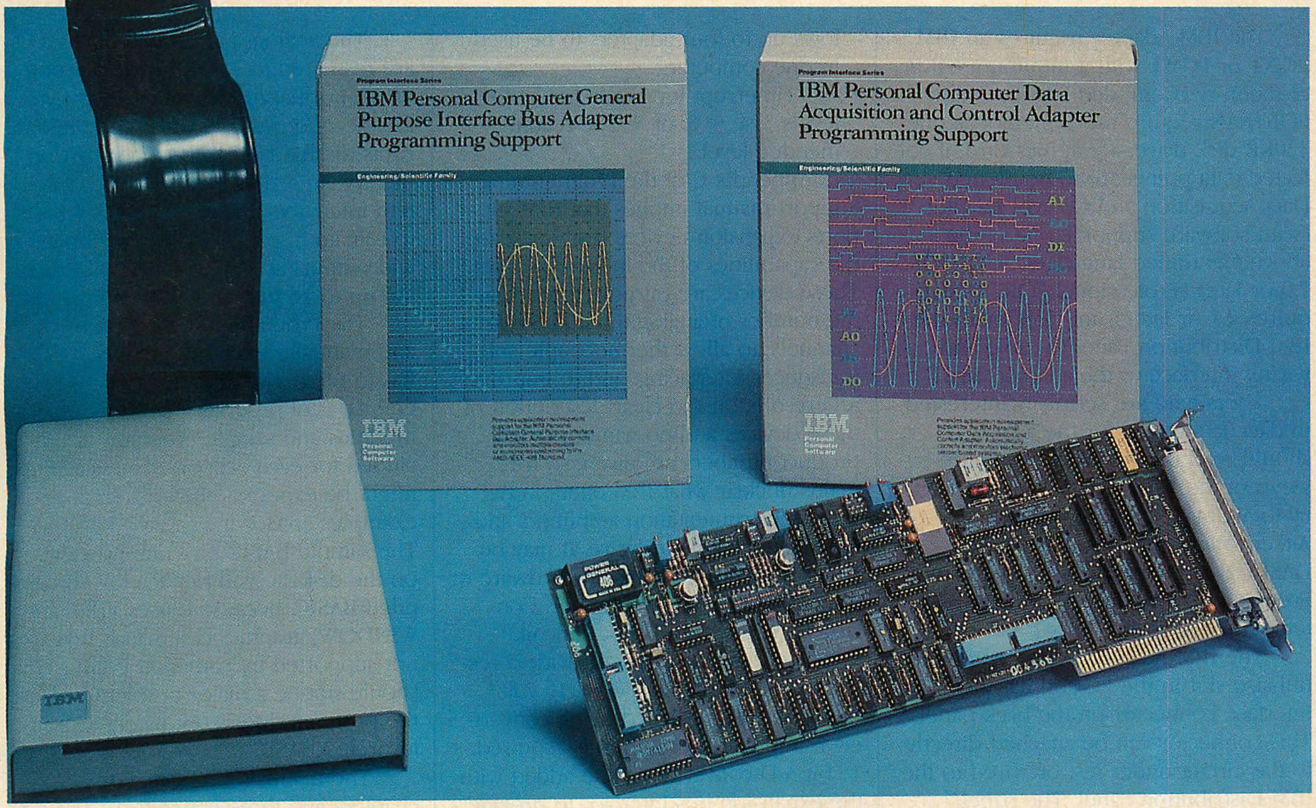




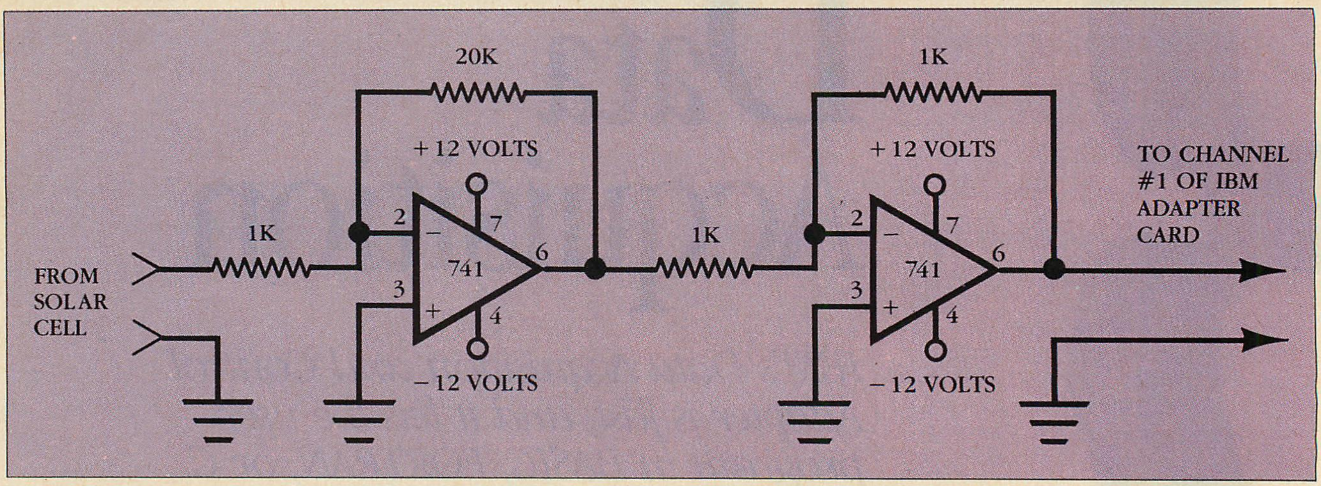
PHOTOGRAPH • STEVE BORNS

WILLIAM MURRAY

The IBM Data Acquisition and Control Adapter with Programming Support (commonly referred to as the IBM Adapter) is one of IBM's entries into the growing market of analog-to-digital (A/D) and digital-to-analog (D/A) data-acquisition boards for the IBM PC/XT and PC/AT family. The IBM Adapter permits the user to have four channels of multiplexed analog input, two channels of analog output, one 16-bit binary input port, one 16-bit binary output port, and one 16-bit addressable counter.

The software support provided with the board allows the user to program in FORTRAN (version 2.0 and Professional), C (Lattice version 2.0), and BASIC (Interpreted or Compiled). The diskette that accompanies the well-written manual contains the "link-time" object modules for interfacing compiled languages with the adapter. For interpreted BASIC, the diskette contains a "header" program that can merge with the user's BASICA program (it becomes lines 1 to 100 of the program) for interfacing to the adapter.

FIGURE 1: *Amplifier Circuit*



Operational amplifiers are necessary to increase the output of the solar cell to a level compatible with the adapter's input.

The IBM Adapter requires an IBM PC/XT or PC/AT with a minimum 64KB of memory (Compiled BASIC, C, and FORTRAN require more memory); one 320KB disk drive; a graphics card, if collected data points are to be plotted; Data Acquisition and Control Adapter (with software support); one of the above-mentioned languages, with DOS 2.0 or later (Professional FORTRAN requires 2.1 or later); and (optional) the IBM Distribution Panel (a cable and wiring interface to the adapter card).

Users who are seriously interested in data acquisition for the XT or AT should read the *PC Tech Journal* reviews of the Tecmar Lab Master ("Digital-to-Analog, Analog-to-Digital," Peter G. Aitken, March 1984, p. 104) and the DASCON-1 ("Poor Richard's Converter: From A to D," William H. Murray, September 1984, p. 30).

The IBM Adapter board fits into a full-size slot in the PC and has a 60-pin interface connector on the back panel. This connector can be attached directly to the circuit under test or wired to the IBM Distribution Panel. The panel, which has a four-foot shielded cable, makes it easy to connect "test circuits" to the adapter with a screwdriver and connecting wires. The panel provides 88 barrier-type screw terminals for access to all 60 lines from the adapter; frequent grounds are also present.

The adapter contains several switches that configure the board:

- The two analog outputs can be set independently for outputs of −5 to +5, −10 to +10, or 0 to +10 volts.
- The four analog inputs are set together for −5 to +5, −10 to +10, or 0 to +10 volts.
- The adapter number (0, 1, 2, 3) allows up to four adapters to be used in one computer.
- IRQ (interrupt level) can be set for levels 3, 4, 5, 6, or 7. The recommended level is 7.

Appendix C of the Programming Support manual implies that IBM supports expansion devices that "increase the capabilities of the internal adapter." These devices are purported to expand the number of analog input and output channels, to allow thermocouple and transducer interfacing, and to improve A/D resolution. No clear description of these devices and no names or IBM product numbers are given, so it remains unclear what IBM offers in the way of instrumentation amplifiers and other interfacing hardware. It may be necessary to construct such hardware or to consult a third-party vendor. Construction, however, is not difficult.

The four A/D inputs provide a resolution of .0025 volts over a 10-volt range with the installed 12-bit converter. If improved resolution is required, a 16-bit A/D converter can be added with the expansion bus interface to provide a resolution of .0001 volts over a 10-volt range. The four A/D inputs are multiplexed. The manual states that 7,999 samples/second are possible in the normal performance mode and that 12,500-16,000 are possible in the extended performance mode, which requires special access to device drivers.

The IBM Adapter provides no onboard instrumentation amplifiers. If the devices that are to be interfaced have outputs that fall outside all of the three selectable A/D input voltages (solar cells, thermocouples, or transducers come to mind), a special amplifier will have to be purchased or built.

The analog outputs and binary I/O are restricted to 7,999 samples/second in the normal mode, with 17,000 samples/second possible with system interrupts disabled. (If some other part of the system requires regular use of system interrupts, the interrupts will have to remain in effect). All binary inputs and outputs are TTL-compatible, providing up to 16 bits of digital information.

The Programming Support software and manual are among the nicest IBM has to offer. The diskette contains several types of programs. Linkable object modules and sample programs are included for each supported language. As might be expected, the only graphics examples are for interpreted BASIC. The sample BASIC program provided on the diskette will *not* work with compiled BASIC, because it uses VIEW and WINDOW, graphics commands that are not supported by compiled BASIC. This should not be a major problem because the program does work nicely with interpreted BASIC.

The manual is divided into seven chapters and three appendices. The first two chapters contain detailed discussions of the converter and data-acquisition techniques, including such topics as A/D and D/A conversion, sampling theory, synchronizing data (handshaking, triggering, and clocking), and event-counting. Chapter 3 introduces the various functions that are available for interfacing software to the adapter (see table 1). Chapter 4 describes the function arguments that must be used when calling the functions. Chapters 5, 6, and 7 describe the calling syntax for each function from each of the three supported languages; abundant example code is included.

IBM ADAPTER

Each language (BASIC, FORTRAN, or C) permits complete control of the IBM Adapter. The execution speed of all three compilers were about equal, because the rate at which the adapter provides samples is the same regardless of how the adapter is accessed.

As soon as a programming language has been selected, an installation program loads a CONFIG.SYS file (containing the invocation of the adapter's device driver) onto a formatted diskette. The system must be booted with that diskette; it could crash if a device driver that is not loaded is called.

Three examples, one in each of the supported languages, will help explain how the adapter is accessed. The C example asks the adapter to do relatively simple tasks, the FORTRAN example asks it to do slightly more complex jobs, and the compiled BASIC example requires the most complicated work.

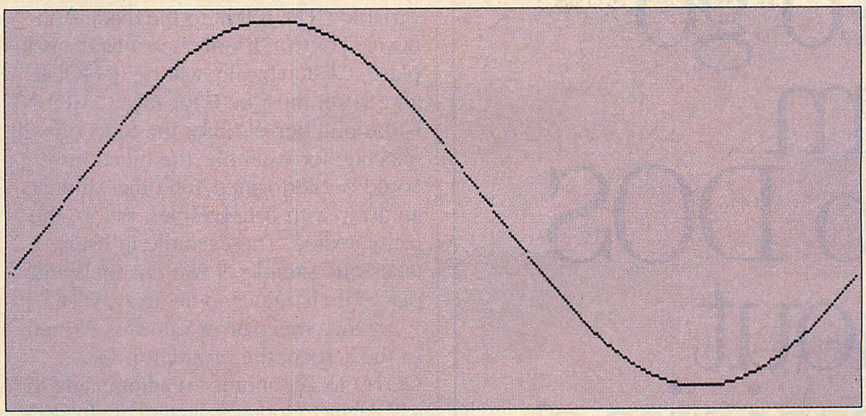
Listing 1 shows a simple C program that makes use of the BINS (Binary Input Simple) call. BINS inputs a 16-bit binary word from the adapter that it stores in a variable called **v**. This variable is modified slightly to give the correct weight for the particular data bit (for example, bit 0=1, bit 1=2, bit 3=4 . . . and bit 15=32,768). The program is designed to report continuously the current data value to the screen.

The variable **adapt** refers to the DA adapter number. If only one adapter is in place, this number will be 0. The **device** number varies depending upon the functions that are to be accessed. Number 8 permits binary I/O, 9 permits analog I/O, and 10 gains access to the 16-bit counter. The **hndshk** variable is reserved and must be a 0. The data variable, **v**, must contain an integer or integer array. The variable **stat** is initially set to 0. A nonzero value returned indicates a failure of the function. Good programmers would use this feature to report and recover from conversion problems.

When Lattice C is used, the large C model (CL) must be used when compiling. The small C model is the default, so it is necessary for the user to specify the large model when invoking the C compiler and linker.

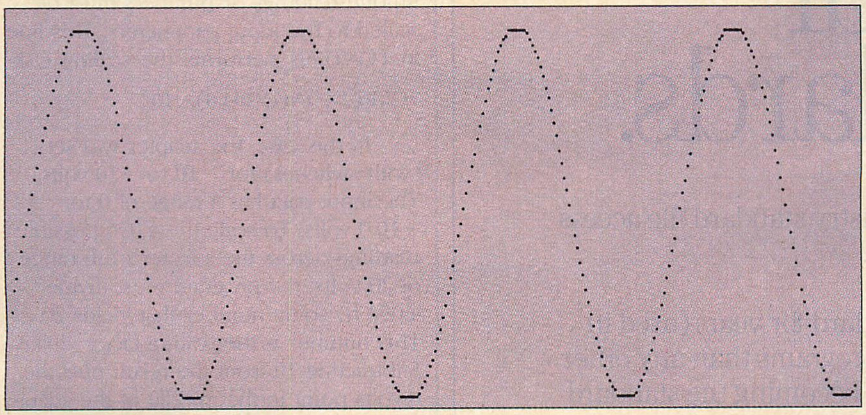
Suppose that a user wants to monitor two of the four available analog inputs. This is called *scanning* on the adapter card. One input will be from a solar cell with a maximum output voltage of +0.5 volts, and the other will be from a variable power supply with a range of 0 to +10 volts. Apart from scanning two inputs, the interface software will not be especially complicated.

FIGURE 2: *60-Hz Sine Wave*



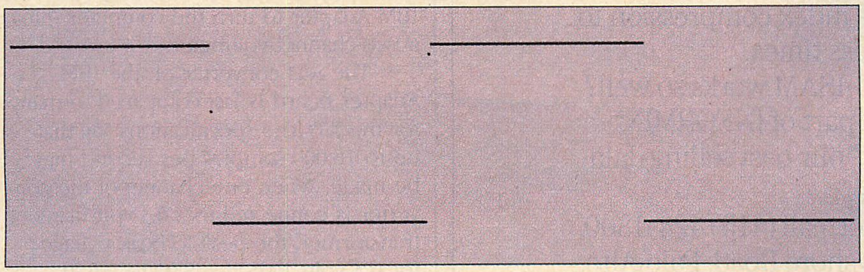
These are the results of using an A/D channel to track a 60-Hz sine wave. The program took 320 samples at 19,200 samples/second.

FIGURE 3: *240-Hz Sine Wave*



The tracking rate was 76,800 samples/second. The four wave forms indicate that 19,200 samples/second is about the maximum sampling rate.

FIGURE 4: *120-Hz Square Wave*



These are the results of tracking a 120-Hz square wave. Note the two data points that were captured on the rise and fall of the square wave.

Listing 2 is a FORTRAN program that will print the voltage values of each input channel to the screen.

There is a catch in the interfacing of the input devices. The power supply is well matched to the adapter's input (0 to +10 volts), but the solar cell can output only +0.5 volts. Without an "on-board" instrumentation amplifier, the resolution of the readings will suffer if the solar cell is connected directly to the adapter. Figure 1 shows a simple operational amplifier circuit that will amplify the +0.5 volts of the solar cell to +10.0 volts. In this circuit, the common 741 op-amp was chosen because of noncritical sampling conditions. This same op-amp circuit could be used for expanding the input-voltage swing of other low-voltage transducers.

The program in listing 2 makes use of the AINSC call (Analog Input Scan) for monitoring up to four analog inputs. CHANLO is the first channel to be sam-

pled and CHANHI is the last. Thus channels 0 and 1 are being monitored. The variable CTRL refers to the expansion-device control. If only one adapter is in place, CTRL typically will be 0. MODE and STOR must be 0 for AINSC. COUNT is the number of times the function will execute; for example, the function could be performed 100 times, filling an array with data samples, before the call is exited. The example in listing 2 takes one sample of two channels and places their values in an array, V(I).

Once this pair of values is written to the screen, the program uses a GOTO to get another reading using the call AINSC. Notice that the data in V(I) are conditioned before being reported to the screen as VOLTS. The A/D converter is a 12-bit device capable of $2^{12}=4{,}096$ unique readings. These unique readings or numbers must be scaled to the input parameters. This line in FORTRAN performs the scaling task:

```
VOLTS(I)=(V(i)/204.8)-10
```

In this case, the adapter was set (with switches) for −10 to +10 volts. The input data has a range of 0 to +10.0 volts. To scale the 4,096 possible readings across the adapter's full range of 20 volts, the program must divide 4,096 by some number that yields 20. This number is the scaling factor, 204.8. Subtracting 10 from the result puts the 0-volts point in the middle of the adapter's range rather than at the bottom. The formatting is set to give two digits of decimal precision. Remember that the resolution is .0025 volts over a 10-volt range. This program works with the IBM Adapter to turn the computer into a two-channel voltmeter.

The A/D converter on the IBM Adapter board is fast compared to many for the XT. The specifications say that up to 16,000 samples per second may be made. When one channel of the converter is connected to a 6.3-volt filament transformer, the peak-to-peak voltage for 6.3 volts RMS is −8.91 to +8.91 volts. If the converter were fast, it would have no trouble tracking and sampling a 60-Hz sine wave.

Because one whole sine wave is executed in 1/60=.016667 seconds and 320 points must be plotted on the medium-resolution screen, readings must be taken every .016667/320=.00005208 seconds. The reciprocal of .00005208 yields a sampling rate of 19,200 Hz (samples/second), which should be an interesting test of the 16,000-Hz limit.

The compiled BASIC program in listing 3 allows the user to set the sam-

TABLE 1: *Interfacing Functions*

FUNCTION	PURPOSE
Analog Input Multiple (AINM)	Perform an iterative analog input COUNT times
Analog Input Simple (AINS)	Perform a single analog input operation
Analog Input Scan (AINSC)	Accept input consecutively from adjacent channels
Analog Output Multiple (AOUM)	Perform an iterative analog output COUNT times
Analog Output Simple (AOUS)	Perform a single analog output operation
Binary Input Multiple (BINM)	Perform an iterative 16-bit binary input COUNT times
Binary Input Simple (BINS)	Perform a single 16-bit binary input operation
Binary Bit Input Simple (BITINS)	Input state of bit # BIT from binary input port
Binary Bit Output Simple (BITOUS)	Set the state of bit # BIT in binary output word
Binary Output Multiple (BOUM)	Iteratively output 16-bit binary words COUNT times
Binary Output Simple (BOUS)	Output a single 16-bit binary word
Counter Input Multiple (CINM)	Iteratively input counter value COUNT times
Counter Input Simple (CINS)	Perform a single read of counter value
Counter Set (CSET)	Initialize counter value
Delay Execution (DELAY)	Software delay for sampling interval > 1 second

These 15 functions, which are used for interfacing software to the adapter, are all available from BASIC, FORTRAN, and C.

pling rate each time the program is run; it displays on the screen the important parameters that are being passed to AINM; it also permits the user to save the screen plot to a diskette in drive B:. Listing 4 is an additional program that lets the screen image be loaded from interpreted BASICA.

Comprehension of this program requires an understanding of the function AINM. Many of the variables that are passed to AINM have already been discussed in connection with listings 1 and 2. MODE controls the system's interrupts and may take on one of two values: if MODE=0, normal system interrupts are possible; if MODE=128, the device driver inhibits system interrupts, thereby increasing I/O performance. (In this example, MODE=128). COUNT is set to 320, because 320 samples must be taken during the pass over the sine wave. The values that are returned will be placed in an array, V%. A unique plot will be obtained each time the program is run, because the sine wave will be "caught" at a different location when the sampling begins. The compiled BASIC program will plot all 320 data points on the medium-resolution screen as white points on a blue background. Figure 2 is a plot of a 60-Hz sine wave from the 6.3-volt filament transformer.

This was the first time I had ever attempted such high sampling rates from an A/D converter on a small system; I hooked up a Heathkit Sine/Square generator and increased the frequency of the sine wave to 240 Hz and the sampling rate to 76,800.

As the results in figure 3 show, something went wrong. Because I increased both the frequency and the sampling rate by a factor of four, there still should have been only one cycle of a sine wave on the screen. Instead, four full sine waves were plotted: apparently, 19,200 samples/second is (or is close to) the upper sampling limit. Increasing the number entered for the sampling rate will not change what is physically impossible. With the sampling rate nearly unchanged and the frequency increasing by a factor of four, the program plotted approximately four complete sine waves.

In another experiment the square-wave generator was hooked to the A/D converter and the frequency was set to 120 Hz and the sampling rate to 19,200. Figure 4 is a plot of the data gathered. These examples show that although the A/D converter is no match for a quality oscilloscope, it does give experimenters a new tool for monitoring and recording relatively low frequency events.

A number of data acquisition boards with many different options are on the market for the IBM PC/XT and PC/AT. The IBM Data Acquisition Adapt-

er does not come loaded with accessories, such as built-in instrument amplifiers, thermometer probes, etc., but it would be a good choice because of its flexibility and quality of workmanship.

The manual is a big plus for the IBM Adapter. It serves not only as a user's guide, but also as an excellent source of sample programs. It takes only minutes to go "from box to data sample" with the IBM Adapter.

The only drawback of the adapter and its supporting software is that assembly language is not supported as a programming option. Furthermore, IBM does not give enough information on the adapter's hardware port assignments or low-level details of the device-driver calling syntax to enable even an experienced assembly language programmer to create his own assembly language calling library. Nonetheless, the three supported languages are versatile and capable enough to make the IBM Adapter a powerful tool for laboratory data acquisition.

IBM Data Acquisition and Control Adapter: $1,275; Distribution Panel: $245
Programming Support: $160
IBM Corporation
5201 Congress
Boca Raton, FL 33431
Contact local IBM dealer
CIRCLE 351 ON READER SERVICE CARD

William Murray teaches computer science at Broome Community College located in Binghamton, New York.

LISTING 1: ONEREAD.C

```
/* Program continuously reads 16 bit binary input */
#include "a:stdio.h"
main()
{
int adapt, device, hndshk, v, stat, answer;
adapt=0;
device=8;
hndshk=0;
stat=0;
repeat: bins (adapt, device, hndshk, &v, &stat);
answer=abs(v)-1;
printf(" %d\n",answer);
goto repeat;
}
```

LISTING 2: TWOREAD.FOR

```
C       FORTRAN PROGRAM WILL SCAN ANALOG INPUTS 0 AND 1
C       THE RATE WILL BE 500 SCANS/SECOND
C       PROGRAM WILL OUTPUT DATA TO SCREEN UNTIL INTERRUPTED
        REAL*4 VOLTS(2)
        INTEGER*2 V(2)
        INTEGER*2 ADAPT,DEVICE,CHANLO,CHANHI,CTRL,
     *  MODE,STOR,STAT
        INTEGER*4 COUNT,RATE
        ADAPT=0
        DEVICE=9
        CHANLO=0
        CHANHI=1
        CTRL=0
        MODE=0
        STOR=0
        COUNT=1
        RATE=1000
        STAT=0
100     CALL AINSC (ADAPT,DEVICE,CHANLO,CHANHI,CTRL,
     *  MODE,STOR,COUNT,RATE,V(1),STAT)
        DO 110 I=1,2
        VOLTS(I)=(V(I)/204.8)-10
110     CONTINUE
        WRITE (*,130)VOLTS
130     FORMAT (1X,F10.2,F10.2)
        GOTO 100
        END
```

LISTING 3: DAPLOT.BAS

```
CLS
PRINT "THIS PROGRAM"
PRINT "PLOTS MULTIPLE DATA POINTS GATHERED BY A/D CONVERTER"
PRINT
PRINT "ENTER THE SAMPLING RATE (samples/second): ":INPUT RATE
CLS
PRINT "THESE ARE THE PARAMETERS WHICH ARE SET FOR THE A/D CARD"
PRINT
ADAPT%=0
DEVICE%=9
MODE%=128
STOR%=0
STAT%=0
CHANLO%=1
CTRL%=0
COUNT=320
DIM V%(319)
PRINT "USING ADAPT NUMBER: ";ADAPT%
PRINT "WITH DEVICE NUMBER: ";DEVICE%
PRINT "EXPANSION DEVICE CONTROL NUMBER: ";CTRL%
PRINT "EXECUTION MODE: ";MODE%
PRINT "CHANNEL ACCESSED: ";CHANLO%
PRINT "NUMBER OF SAMPLES: ";COUNT
PRINT "RATE OF SAMPLING (SAMPLES/SECOND): ";RATE
PRINT
PRINT
PRINT "Shall I save this plot? (type 1 for YES, 2 for NO)"
INPUT TX
IF TX=1 THEN PRINT "ENTER FILE NAME (NO EXTENSIONS)":INPUT P$
PRINT
PRINT "once the plot is complete, hit any key to save"
PRINT
PRINT
PRINT "NOW STRIKE A KEY TO TAKE SAMPLES"
INPUT SS$
CLS
CALL AINM (APAPT%,DEVICE%,CHANLO%,CTRL%,MODE%,
        STOR%,COUNT,RATE,V%(0),STAT%)
SCREEN 1
COLOR 1,7,7
FOR I=0 TO 319
Z=-(V%(I)*6/204.8)+150
PSET(I,Z),14
NEXT I
INPUT SS$
IF TX=2 THEN GOTO 1000
DEF SEG=&HB800
P1$="B:
P2$="
PP$=P1$+P$+P2$
BSAVE PP$,0,&H4000
1000 END
```

LISTING 4: PLOTLOAD.BAS

```
10 CLS
20 PRINT "PROGRAM LOADS A SCREEN IMAGE SAVED BY A PREVIOUS PROGRAM"
30 PRINT
40 PRINT "THIS PROGRAM ASSUMES THAT THE PICTURE IS IN THE B DRIVE"
50 PRINT
60 PRINT "ENTER THE NAME OF THE PICTURE TO BE LOADED (NO EXTENSIONS)
70 INPUT P$
80 CLS
90 SCREEN 1
100 COLOR 1,7,7
110 KEY OFF
120 DEF SEG=&HB800
130 P1$="B:
140 P3$="
150 P2$=P1$+P$+P3$
160 BLOAD P2$,0
170 REM PUSH THE F1 KEY TO RETURN TO BASIC
180 ON KEY(1) GOSUB 210
190 KEY(1) ON
200 GOTO 190
210 END
```

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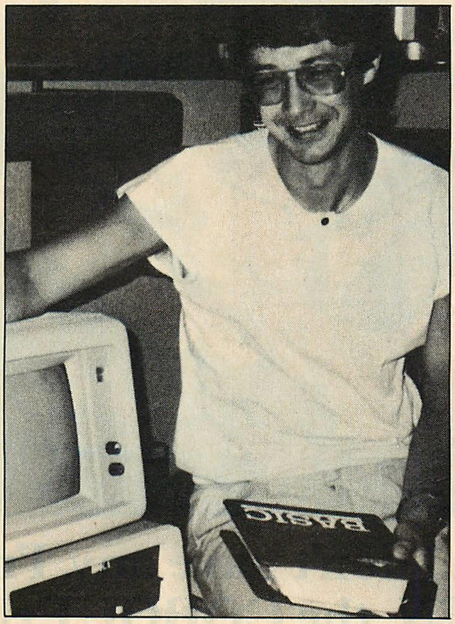

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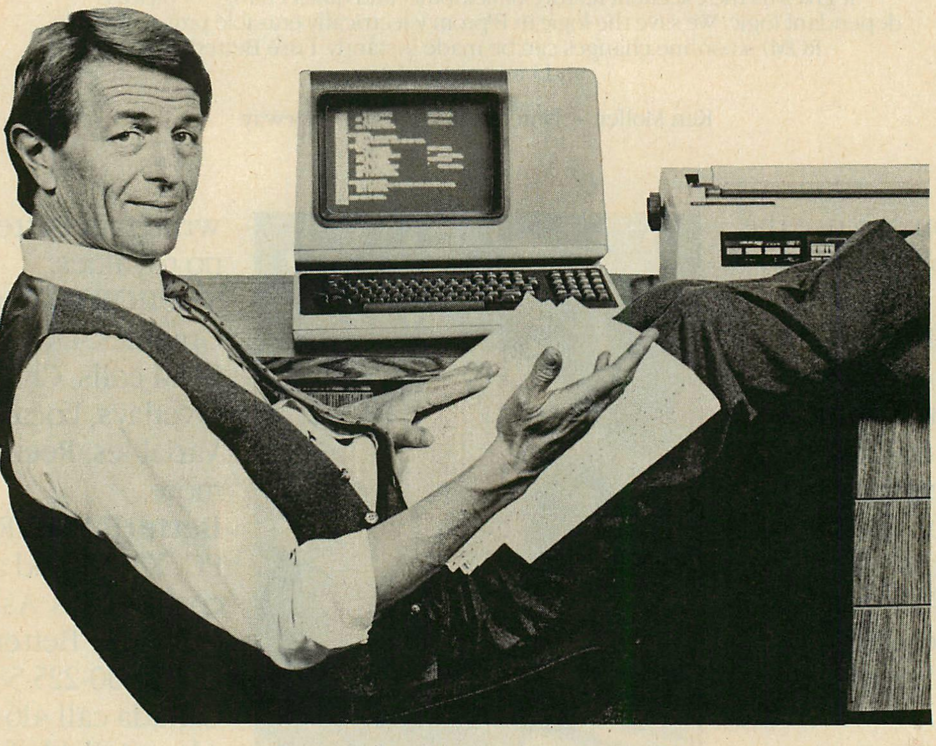

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COBOL Performs

Three high-level compilers give the programmer a lot to consider regarding what is necessary at ANSI level 2.

TED MIRECKI

This is the second of three articles on COBOL compilers for the IBM PC. The first article, which appeared in the June issue (page 58), reviewed compilers from Ryan-McFarland and Realia. This article reviews compilers from Microsoft, Micro Focus, and Digital Research.

Having considered two low-intermediate compilers in the first article, the series takes a turn: the three compilers reviewed here are from the opposite end of the COBOL spectrum—certified at the high level.

Federal certification and the criteria for each certification level were discussed previously, but, in short, high-level certification requires the implementation of all COBOL functional modules at ANSI level 2. The Micro Focus and Digital Research compilers comply in this respect, but Microsoft COBOL implements only part of the Debug module and none of the Communications module. How, then, can it claim high-level certification?

The Federal Software Testing Center, the agency within the General Services Administration (GSA) that issues the certifications, validated Microsoft COBOL version 2.0 at the high level, but "with errors" because it did not pass the tests in Debug and Communications. A compiler rated "with errors" must be corrected within one year or the certification is withdrawn or downgraded. (The agency did not offer an explanation as to why a compiler might be certified at high level "with errors" instead of at a lower level.)

However, the quest for high-level certification is more important to marketing and advertising people than to COBOL programmers. The federal criteria predate the use of COBOL on microcomputers and other interactive systems, such as time-sharing, so they do not reflect contemporary needs. An interactive debugger, for instance, is much more useful than the ANSI level 2 Debug module, and even the internal sort (another requirement for high-

PHOTOGRAPH • MARC DAVID COHEN

intermediate and high certification) is rarely used in interactive applications, especially if multikey indexed files are efficiently implemented. As for ANSI Communications, this module does not support interrupt-driven asynchronous communications as understood by most micro users, but queued message handling, and not in realtime, for multiuser systems. This quote from the Communications chapter in the Digital Research COBOL Programmer's Guide says it all:

> The communications facilities provided by Digital Research Level II COBOL are included for certification purposes with the General Services Administration (GSA). In a single-user, single-tasking environment they have no meaning.

TABLE 1: *Compiler Performance*

	MICROSOFT	MICRO FOCUS	DIGITAL RESEARCH
ERATOSTHENES SIEVE (80 lines)			
Compile	1:04	0:30	2:08
Native code generate	–	1:16	–
Intermediate code size	10.2KB	10.0KB	–
Native code size	–	12.2KB	12.2KB
FILE I/O (350 lines)			
Compile	1:53	0:40	3:37
Native code generate	–	1:57	–
Intermediate code size	5.8KB	4.1KB	–
Native code size	–	8.4KB	8.4KB
MEDIUM-SIZE PROGRAM (500 lines)			
Compile	3:16	0:50	5:20
Native code generate	–	2:55	–
Intermediate code size	7.5KB	4.9KB	–
Native code size	–	10.6KB	10.6KB
LARGE PROGRAM (1,000 lines)			
Compile	6:43	1:25	9:33
Native code generate	–	5:15	–
Intermediate code size	14.7KB	8.7KB	–
Native code size	–	18.6KB	18.6KB
GIBSON MIX (1,500 lines)			
Compile	6:35	1:49	9:34
Native code generate	–	5:02	–
Intermediate code size	21.3KB	15.9KB	–
Native code size	–	24.6KB	24.6KB

Compilation speed in minutes:seconds.

All compilation and execution tests were run on floppy disk to provide an indication of worst-case performance. The DRI compiler is quite slow and its performance does not improve greatly when running on a RAM disk.

THE COMPILERS

Microsoft COBOL 2.0. An update of version 1.0, previously available from Microsoft and IBM, this is an incremental compiler—it produces intermediate code that is interpreted by a runtime system. This is not really a step backward from version 1.0; although that version also produced intermediate code into a .OBJ file, it then had to be converted to .EXE format with the linker, and then was interpreted, not executed directly. The new version's code is ready to execute after compilation; the charade of the link step has been eliminated. Linking separately compiled subprograms is still possible, as explained in the section on Inter-Program Communications.

All other features of Microsoft COBOL (except the Communications and Debug modules) are fully implemented at ANSI level 2. The result is a language significantly more powerful than version 1.0. The withdrawal of the high-level certification, should it occur, should not adversely reflect on this product's capabilities. It includes an interactive symbolic debugger and provides debugging extensions in the source language; together these features run rings around ANSI level 2 Debug.

Other programs included in the package are an install utility for configuring display parameters to the system hardware, a resident ISAM (indexed file) utility, a REBUILD program to recover damaged indexed files, and the standard LINK program to link assembly language (but not COBOL) subprograms into the runtime system. Version 2.0 costs $700. Distributing runtime applications requires a licensing agreement with Microsoft, but no licensing fees are charged. System requirements for this compiler are 192KB of memory and two double-sided disk drives.

Micro Focus Level II COBOL 2.62. Micro Focus' was the first high-level COBOL compiler for the PC. This implementation is as standard as they come and quite powerful. It requires 256KB of memory and two double-sided drives; however, a hard disk is recommended. (As an aside, Micro Focus is an English company, but its American market is supported by a California-based subsidiary—no need to worry about transatlantic calls for technical support.)

The first compilation step produces intermediate code, but this is not a regular incremental compiler. The intermediate code may be executed by the runtime system or converted to native machine code. Native code also may be executed by the runtime system, or it may be linked into that system to form a stand-alone application executable from DOS. This scheme provides the best balance between speed of compilation and execution: during development, intermediate code may be quickly generated and tested without additional processing, and finished applications may then be converted to native code for faster execution.

This compiler costs $1,500; runtime licensing fees are $80 per machine for internal use within the purchasing company and $40 per program for marketed applications. Various optional packages are available at extra cost: an interactive, source-oriented debugger (ANIMATOR), a FORMS utility for creating formatted screens, and a file-sharing utility for multiuser systems. None of these was available for testing.

Digital Research Level II COBOL 3.0. This compiler is like the Micro Focus product, but in a different package: the version number probably indicates a revision of the Micro Focus compiler rather than a previous incarnation of DRI COBOL. The same source programs can be compiled by either with no changes except formatted screen I/O; even for a language as standardized as COBOL supposedly is, that is noteworthy.

Unfortunately, DRI dropped some of the best features of Micro Focus. Native code is produced automatically,

with no opportunity to stop at the intermediate stage. This significantly lengthens test compilations. Screen and file I/O are handled by the DRI products Display Manager and Access Manager. But the versions of these utilities supplied are specific to this compiler; they are not usable with other DRI languages. They do not provide the performance of the corresponding Micro Focus facilities. The DRI compiler is $700, with no runtime licensing fees. It requires a minimum of 192KB of memory, with 256KB recommended, and two double-sided drives.

COMPILERS: ROUND TWO

The same programs were used to test these compilers as were used for the previous two (results are shown in table 1); listings were published with the first article. Minor changes had to be made to certain Environment and Data Division statements to reflect implementation differences. One new program (see listing 1) was required to test the internal sort, a feature not provided by the Ryan-McFarland and Realia compilers. This program should indicate how to modify the other benchmark programs for these compilers. The two copy files also included with the first article, TIMERDAT and TIMERPRO, are needed by this program. They should have extensions of .COB for Microsoft and .CBL for Micro Focus and DRI.

Micro Focus technical support is excellent and accessible; the staff seems to consist mostly of COBOL experts.

All three compilers assume that the user has some familiarity with programming in general and COBOL in particular. No tutorials are provided, and the general introductory information that is included is meant only as a refresher. Only Microsoft recommends a list of books for learning the language.

The Microsoft COBOL documentation follows the usual formal for that company's products: two green plastic binders, 5½ by 8½ inches, packaged in a plastic box that comes apart at the hinge on the first opening. Included are a user's guide and a language reference. Both manuals are written in a refreshingly light and active tone, often in first person. Examples, a rarity in COBOL manuals, are abundant here, and both manuals include indexes.

The language reference bears the only flaw—some inconsistent organization. File I/O is treated in a separate chapter for each access mode (Sequential, Relative, Indexed), but each I/O verb has a cross-reference in the alphabetically arranged Procedure Division chapter. On the other hand, ACCEPT and DISPLAY are fully explained in the Procedure Division chapter, a chapter that would be more useful if it included only cursory syntax specifications and relegated lengthy statement explanations to a chapter on console I/O.

Many entries are arranged alphabetically, where a more logical grouping would follow the natural hierarchy of COBOL syntax. For example, in the section on File Control in the Environment Division, the descriptions of ACCESS MODE and ASSIGN clauses precede the SELECT clause. Ordering these as they should appear in the source code would be much less confusing, especially to a new COBOL programmer.

Microsoft's telephone support is good: inquiries are handled promptly, even though COBOL experts are not plentiful among the support staff. Occasionally information is garbled when it comes through several persons (see the explanation of COMPUTATIONAL types under Language Implementation), but the correct answer eventually emerges.

Micro Focus documentation consists of an operating guide and language reference in two plastic binders with an odd page size: 7¼ by 8½ inches. (Just what the world and your documentation shelf need: another variation on size.) The glossy finish and thin type make reading difficult under certain lighting conditions. And although a detailed table of contents can be nice, at 29 pages the one in the reference is too detailed. Index tabs and chapter title headers on each page would help. Fortunately, a useful index is included (with only half as many pages).

The writing is ponderous and wordy, requiring a careful reading to ferret out information. Although it is certainly complete, other manuals (Microsoft, Ryan-McFarland) provide the same information in half the verbiage. The documentation is good overall: a product with a price tag of $1,500 is naturally held to a higher standard.

Micro Focus technical support is excellent and readily accessible; the staff seems to consist mostly of COBOL experts. During testing, a question arose about the assembly language interface. (The culprit turned out to be a

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```
          Save Group: TAXES
             Library: c:/archive
   Current Directory: c:/usr/taxdata

Bac   Origin: c:/usr/taxdata
      Subdir: ./schedc
Res    : DEPREC80.DAT       5120   --r-   3/28/85 11:26
       : DEPREC84.DAT      10240   --r-   3/29/85 11:41
       : OFSUPPLY.DAT       5632   ----   3/27/85 02:33
       : TEXPENSE.DAT       4608   ----   3/27/85 15:18

      Subdir: ./schedd
       : CVGTBUY .DAT       1024   ----   3/30/85 09:47
Sel    : CVGTSELL.DAT       1024   ----   3/30/85 09:51
       : IBMBUY  .DAT       4096   ----   3/30/85 10:10
       : IBMSELL .DAT       4096   ----   3/30/85 14:21
         FILES:     8      35840   Bytes

FLASHBACK -- Version 1.00                     ../USR
(c) Copyright 1985, GRAND MAX                   ./taxdata
                                              15:31
>BACKUP *.DAT;3/27/85-3/30/85                 15:32
1 EXIT 2 PAUSE 3 MENU 4 COMAND 5 DOS 6 7 8 9 0 HELP
```

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missing update section containing information that was inadvertently left out of the operating guide.) The first person asked could not answer the question, but checked with the home office in England and had an answer the next day. Not only were the errata pages brought to light (which clarified everything), but so were the underlying reasons for the various methods of calling assembly language programs. For the end of this story, read on.

Digital Research supplies essentially the same documentation as Micro Focus, repackaged in DRI standard-issue brown binders and slip cases. The type has been reset and printed on matte paper—much more readable. The operating guide is revised to reflect the lack of intermediate code output and the differences in file and screen I/O methods. But the revision was not extensive enough: the information on the assembly language interface that was missing from the Micro Focus manual is also missing here, and this time no updates or errata pages are available.

Documentation for the Access Manager is quite clear, although most of its file management functions will seldom be called explicitly because they are handled by standard COBOL statements. On the other hand, the Display Manager, necessary to any kind of screen I/O beyond "glass teletype," is virtually unusable for lack of documentation. Definitions of calling sequences for the functions do not specify the data descriptions of the parameters: display or computational, decimal or binary, their length. Some of the documented calling sequences do not match the examples in the sample programs, either in number or order of parameters. Because the sample programs work, however, one can only assume that the documentation is incorrect, at least for those few functions illustrated. This does not inspire confidence in the documentation.

Other problems suggest that the documentation was issued without proper editing: A READ.ME file, referenced in the operating guide, allegedly demonstrates file and screen I/O methods, but that file only refers the user back to the manual. In the language reference, the optional Micro Focus ANIMATOR debugger is mentioned, but it is not supported by the DRI compiler, and the descriptions of indexed file structure and recovery procedures are for Micro Focus files, not DRI files, which have a totally different structure.

DRI technical support also is lacking. The COBOL compiler is a new product for the company (the review

copy was serial number 3) and it was not developed by DRI; the staff requires written documentation of problems to study them. Time, however, should improve the situation. An additional annoyance is the difficulty in getting through to the DRI staff (fortunately, the personnel are receptive).

Installation of Microsoft COBOL entails configuring the runtime system and debugger to the characteristics of the display. For the IBM PC and other common displays, this means a selection from a menu; other hardware may require complete specifications. The compiler, runtime system, debugger, DOS, source, and output files fit tightly on two floppy disks; they can be distributed in several ways for the most convenient operation. For large programs or systems requiring many source files, three disks may be necessary. DOS path support is good: a path name may be used anywhere a file name is required, both on command lines and within the source, and the compiler and runtime system search the directories specified in the PATH command to find overlays and intermediate code files. Alternate search directories for overlays, intermediate code files, and copy files also may be specified on the command line.

Micro Focus COBOL comes preconfigured for the PC and requires no installation other than making copies of the disks. (The runtime system on the evaluation copy was protected with Prolok, but Micro Focus says that this is not done to fully licensed copies.) A working system requires three disks: compiler, native code generator, and runtime system, and the source programs. A disk swap is required between compilation and testing, even with no generate or link steps. Path names are not allowed in either command lines or source programs, an odd omission considering the length of time that DOS 2.x has been available.

The Digital Research compiler, despite its similarities to Micro Focus, is quite different in operation. The installation section claims that the system is preconfigured for the PC, but the Display Manager's screen editor refuses to run until it is told what terminal it is running on. The compiler does not stop after producing intermediate code, and it takes a significantly longer time to produce the final output than Micro Focus' two-step process does. Both compiler and runtime system come to a stop after displaying a copyright message, waiting for the user to "Press any key." This makes automatic compilation or execution with batch files nearly im-

TABLE 2: *Runtime System Size*

	MICROSOFT	MICRO FOCUS	DIGITAL RESEARCH
Minimum runtime[1]	59.0	37.4	36.4
Indexed file I/O[2]	22.1	23.9	18.2
Formatted screen I/O[3]	–	20.7	16.6
Sort module[4]	–	–	16.9
Maximum size	81.1	82.0	88.1

Measurements in kilobytes (KB) on disk.
[1]Required for all programs, both intermediate and native code.
[2]Required only if program uses indexed I/O.
[3]Required only if program uses formatted screen I/O.
[4]Required only if program uses internal Sort/Merge.

Each compiler's output, whether intermediate or native code, must be executed by a runtime system. The required runtime size depends on the features a program uses; allowance is usually made for the maximum configuration.

TABLE 3: *Benchmarks—Internal Operations and Sort*

	MICRO-SOFT	MICRO FOCUS Inter-mediate	MICRO FOCUS Native	DIGITAL RESEARCH
ERATOSTHENES SIEVE, binary				
Per iteration	16:02	2:04	0:30	0:30
ERATOSTHENES SIEVE, decimal				
Per iteration	18:08	2:29	1:16	1:16
DECIMAL ARITHMETIC				
5,000 iterations	4:04	1:04	0:34	0:34
CHARACTER OPERATIONS				
500 iterations	13.10	2:33	0:40	0:40
SCREEN DISPLAY				
10 iterations	0:30	6.4 secs	5.7 secs	0:47
GIBSON MIX, 10,000 iterations				
Total time	6 hrs. 21 min.	1 hr. 18 min.	17:26	17:27
Calculated S-profile, secs	389	63.7	11.0	11.0
INTERNAL SORT				
300 records	0:29	1:41	1:41	2:27
1,000 records	1:59	8:40	8:34	13:52

Execution times in minutes:seconds unless otherwise noted.

Microsoft emerges the clear loser in everything but the sort: this compiler's code is excruciatingly slow. In the Gibson Mix program, the calculated S-profile is a weighted average execution speed for a certain mix of typical COBOL operations.

possible. No path support is provided and even less flexibility in drive selection: the runtime system insists upon looking for the Display Manager on the same drive as the code file.

PUT TO THE TASK

Table 1 provides the compilation speed and code sizes for the test programs. All compilation and execution tests were run on floppy disks to anticipate a worst-case performance; using a fixed disk or RAM disk improves the results.

Each compiler's output, whether intermediate or native code, must be executed by a runtime system, the sizes of which for each compiler are given in table 2. The required runtime size depends on the features a program uses. In most cases, however, all components will be resident on the disk anyway, so allowance is usually made for the maxi-

mum configuration. Micro Focus intermediate code is the smallest, but that form of compiler output is primarily used for testing, and the native code is more indicative of the size of a finished application. Although code produced by the Micro Focus and DRI compilers is the same length, it is not identical.

The DRI compiler is quite slow and does not improve greatly with a RAM disk. Most of its processing seems to occur in memory, with long pauses between short intervals of disk activity. A user option to stop after the intermediate code phase is noticeably missing.

Execution speed results for internal operations and sorting are shown in table 3. Microsoft emerges the clear loser in everything but the sort: this compiler's code is excrutiatingly slow. For the Gibson Mix program (described in the first article), the recommended number of iterations is 50,000, but this test was run with only 10,000 iterations: the calculated S-profile (a weighted average execution speed for a certain mix of typical COBOL operations) is computed on a per-iteration basis, and for the faster compilers, varies by no more than 5 percent between 10,000 and 50,000 iterations. More iterations ensure that the timings of the individual loops are long enough to avoid problems with the 55-millisecond resolution of the PC system timer. Increasing the number of iterations would not change the relative rankings, with regard to the S-Profile, of the five compilers tested to this point.

Micro Focus and DRI clearly show the advantage of native over intermediate code. For internal operations, native code is two to five times faster, but the execution speed of Micro Focus intermediate code is quite acceptable for testing, given the quick compile times. This is a great compiler for development, producing testable code in the least amount of time. Notice that the results for Micro Focus and DRI native code are identical except for operations supported by DRI utilities: screen display and file I/O in the sort. Here, Micro Focus is much faster; its speed in writing to the screen rivals that of assembly language programs.

Table 4 exhibits benchmark results for file I/O. Microsoft, the slowpoke of the internal benchmarks, leads here, especially in sorting and indexed file operations. It is a strong second to the overall speed champ so far, Realia. For Micro Focus, results for intermediate and native code were not significantly different, so only one set of timings is shown. This is to be expected because disk operations are not materially af-

TABLE 4: *Benchmarks—File Operations*

	100 RECORDS			300 RECORDS		
	MS	MF[1]	DR	MS	MF[1]	DR
SEQUENTIAL I/O						
Write	0:05	0:05	0:05	0:16	0:14	0:14
Read	0:04	0:04	0:04	0:14	0:13	0:13
Copy	0:09	0:10	0:10	0:27	0:24	0:24
RELATIVE I/O						
Write[2]	0:07	0:05	0:05	0:17	0:14	0:14
Read[3]	0:24	0:24	0:24	1:12	0:43	0:43
Update[4]	0:55	0:55	0:55	2:17	2:17	2:17
INDEXED I/O						
Write[5]	0:30	2:10	1:12	1:35	6:19	4:48
Read[6]	0:22	0:24	0:25	1:10	1:19	1:12
Updated[7]	1:05	3:01	—[8]	6:22	9:17	—[8]

All files have fixed-length records of 100 bytes.
Times in minutes:seconds

[1]*Micro Focus times were within 1 or 2 seconds for intermediate and native.*
[2]*Write in sequence by record number.*
[3]*Read nonconsecutive record numbers.*
[4]*Read nonconsecutive record numbers, rewrite each.*
[5]*Write with primary keys not in sequence, one alternate key.*
[6]*Read in different order than written.*
[7]*Read in different order than written, change alternate key.*
[8]*Digital Research could not update correctly; see text.*

Microsoft, the slowpoke of the internal benchmarks, leads here, especially in sorting and indexed file operations. It is a strong second to the overall speed champ so far, Realia. For Micro Focus, results for intermediate and native code were not significantly different, so only one set of timings is shown.

fected by efficiency of code execution. DRI's Access Manager outpaced Micro Focus in those indexed operations it could handle, but was disqualified for failing the update test (discussed in the File I/O section).

Program size limits are the same for all three compilers. An individual program (main or called subprogram) is limited to 64KB of code, so a modular system may be any size consistent with memory availability and data space requirements. For segmented programs, the root segment and the largest overlay must fit within 64KB. Data space is limited to 60KB by Microsoft and to 64KB by Micro Focus and DRI; this limit applies to the entire system, not to each program. Microsoft is wasteful of data space in called programs, as explained (?) by this quote from the manual:

> While LINKAGE SECTION items [passed parameters] reserve no actual space, they are treated as if memory is actually allocated to them. . . . In addition, each level 01 or 77 data-item present is assigned a new 1024-byte area.

Each compiler indicates errors during compilation by displaying the offending course line with a line number assigned by the compiler. The numbers are assigned through any code brought in with COPY statements, making it difficult to find the error location unless the programmer has coded sequence numbers in the program or requests a compilation listing. Microsoft suppresses the listing by default; the other two produce it on disk unless explicitly instructed otherwise. All three support FIPS (Federal Information Processing Standards) flagging, which flags any source statements that exceed a specified federal certification level. Micro Focus and DRI have a compile-time switch that, when set, flags all statements that are extensions to standard ANSI syntax, for example, tables with more than three dimensions (see the section on Table Handling).

Microsoft error messages are unnecessarily detailed. Once the compiler becomes confused by an error, it may display an "unrecognized element" message for every identifier, literal, and parenthesis in the statement. By the time all those messages have appeared, the message indicating the cause of the error may have scrolled off the screen.

Micro Focus displays a full error message for every error; DRI displays an error number that is explained in the manual. Otherwise their error handling is similar. Occasionally they display the wrong line with error mes-

TABLE 5: *Computational Data Types*

	MICROSOFT	MICRO FOCUS and DIGITAL RESEARCH	MAINFRAME VS COBOL
COMP	Display!	Binary integer, 1-8 bytes	Binary integer, 2-4 bytes
COMP-0	Binary integer, 2 bytes	–	–
COMP-1	–	–	Real, 4 bytes
COMP-2	–	–	Real, 8 bytes
COMP-3	Packed decimal, signed	Packed decimal, signed	Packed decimal, signed
COMP-4	Binary integer, 4 bytes	–	Same as COMP

All binary integers are high byte first.

All three compilers support COMP-3 as packed decimal: this usage, although not defined by ANSI, has become a de facto standard. Micro Focus' and DRI's compilers provide only one binary type.

sages—for instance, an error in a multiline sentence usually results in the last line of the sentence being displayed rather than the offending line. This is especially confusing when the error is an undefined or multiply defined identifier, because the displayed line may have a perfectly innocent name mislabeled as undefined or not unique. Micro Focus says this not a bug, that the compiler is designed to scan to the end of a sentence before reporting errors—a poor design choice.

The Microsoft compiler seems robust; no obvious bugs materialized in its operation or its output code. Micro Focus and DRI can be knocked for a loop (pun intended) by simple errors, such as a duplicate FD name, causing them to continually repeat the same error message. Only the error message (or number, in the case of DRI) is repeated, not the line in error, so the cause of the error may scroll off the screen by the time the user notices. Pressing Break interrupts the loop and returns the system to DOS, sometimes leaving lost sectors of intermediate code on the output drive (recoverable with CHKDSK). This is definitely a bug, and Micro Focus is developing a fix.

PUTTING MODULES TO WORK

Nucleus. The computational data types implemented by each compiler are listed in table 5. The types supported by IBM mainframe VS COBOL are included for reference. All three compilers support COMP-3 as packed decimal; this usage, although not defined by ANSI, has become a de facto standard. Micro Focus' and DRI's compilers provide only one binary type; the length varies from one to eight bytes depending on the number of digits in the picture. The range of lengths of binary numbers, up to 18 decimal digits in binary representation, exceeds that provided by most other compilers. Micro Focus and DRI compilers permit specifying numeric literals in hexadecimal form.

The Microsoft documentation does not explain the meaning of COMP (without a numeric suffix). An initial call to the company produced the answer that COMP was "binary real." Hard to believe since very few COBOL compilers support real numbers. However, a subsequent call produced the more believable, but still strange, answer that COMP usage was the same as DISPLAY. This was verified by examining file data with DEBUG. It is unclear why Microsoft would have COMP mean its exact opposite; but at least it remains consistent with the usage in version 1.0.

DRI exhibits a nonstandard (and undocumented) feature of Data Division. Display Manager and Access Manager require copy files that contain data names with a level number of 78 and a value, but no picture. These are real data items, not a strange version of condition names: they are moved to binary (PIC 9999 COMP) fields and passed as parameters in calls that perform the functions provided by these utilities. Even though this feature is undocumented, it seems to work.

All three compilers provide full level 2 implementation of basic Procedure Division operations. The imple-

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mentation is fairly standard, and only screen-handling statements in this division had to be changed when moving a program among compilers.

Microsoft and Micro Focus allow a program to obtain the parameters typed on the command line when the runtime system is invoked; the methods for this are covered under Inter-Program Communications for Microsoft and Console I/O for Micro Focus. There is no apparent way to get parameters into a DRI program, short of resorting to an assembly language routine.

Console I/O. Standard COBOL provides ACCEPT and DISPLAY verbs, which most compilers, including these three, use to implement a "glass teletype" console interface functionally similar to the one used by DOS. While in this mode, Micro Focus and DRI use the DOS keyboard input routine, but they clear the input buffer before each ACCEPT, so that editing the previous input with the function keys is not possible as it is with the DOS command line. To go beyond simple scrolling and provide formatted screen I/O, most compilers resort to nonstandard extensions that play havoc with source code portability.

The DRI compiler transfers the incompatibility from compilation to runtime by providing console functions through subprogram calls to the Display Manager. The calls follow standard COBOL syntax and are acceptable to any compiler, but the routines are not available in any library except DRI's.

Access Manager provides a separate screen editing utility for laying out screen forms and saving them in disk files. The calls from the COBOL program then read in the screen definition

The Microsoft compiler seems to be fairly robust; no obvious bugs materialized either in its operation or its output code.

and manipulate individual fields, each of which was assigned a number when the screen was created. Although a full screen can be displayed with one call, input requires a separate call for each field. Terminating keys can be defined and video attributes can be set individually by field, and the attributes can be changed by the program. Cursor control within and among fields is not built-in, but can be programmed by defining the cursor-movement keys as terminators. The system seems powerful and flexible, even with the tedious coding of the many calls and the control logic to branch among them. But this is the usual trade-off between ease of use and power, and it is a good concept, although nothing short of a major overhaul of its documentation will make the DRI system usable.

Screen handling is an area of major difference between the compilers from DRI and Micro Focus. Micro Focus supports formatted screen I/O at the source language level, with variations of ACCEPT and DISPLAY. The screen is considered a one-dimensional array, and an elementary or group data item is mapped onto it or from it byte by byte. Only one screen coordinate, corresponding to the first byte of the data item, may be specified per statement; multifield screens may be formatted by multiple statements or by separating named fields with FILLER items. FILLERs are not displayed and cannot accept input data, and they do not disturb anything on-screen. An ACCEPT of data from a displayed screen's input fields is most conveniently done by redefining the display and accept groups so that

data items in one are FILLER items in the other. This requires laying out the screen on paper and lots of space counting, but an optional FORMS utility (not tested) permits on-screen form creation and generates copy files containing the required data definitions.

Field editing during Micro Focus full-screen ACCEPT is convenient. The cursor moves nondestructively in both directions, and in alphabetic fields, the insert, delete, and backspace keys work just as in the BASIC editor. Cursor up and down keys move between fields, and any field may be revisited and re-edited before the whole form is submitted for input with the Enter key or a function key. Control of video attributes is less convenient: the only attribute controlled directly within the source is underline; other attributes are set, for the whole screen or a portion, by calls to assembly language routines built into the runtime system.

In a Micro Focus program, the first unformatted (scrolling type) ACCEPT reads the command line parameters instead of the keyboard. Programs using unformatted keyboard input must be prepared to handle the presence or absence of such parameters.

Microsoft COBOL has the most nonstandard way of handling screens. The Data Division is extended by the addition of a SCREEN SECTION, in which the layout of screens is defined. Each screen form is defined as a group structure, with individual fields as elementary items; all the fields of a form are displayed or accepted with one statement. Screen coordinates, video attributes, Working Storage

The DRI compiler accepts normal COBOL indexed I/O syntax and calls primitive data and index functions in the Access Manager.

sources, and destinations of console data, are specified at the field level. Unfortunately, video attributes are hard-coded in the source; the program cannot change them.

Editing Microsoft full-screen forms leaves much to be desired. Within individual fields, only nondestructive cursor moves are supported. Returning the cursor to a previously entered field is possible, but that reinitializes the field: previously entered data in that field and all following fields are lost. All of the fields must be revisited because the entire ACCEPT is ended only when the cursor is in the last field. In numeric fields, once the decimal point is keyed in, the length of the integer part may not be lengthened. For example, if 12. is mistakenly keyed instead of 123., the field must be erased and rekeyed from scratch. Not very user-friendly.

For all three compilers, all displayed and accepted data must have usage set to DISPLAY (the default), as no numeric conversions are performed.

File I/O. Most micro COBOLs, including Micro Focus and DRI, relate program file names to operating system files using the ASSIGN clause in the SELECT statement. But in Microsoft COBOL, the SELECT statement assigns a file to DISK or PRINTER, and the DOS file name is assigned in a VALUE clause in the FD (file definition), as if it were a tape label. In all three, the assignment may be either static, to a file name literal hard-coded in the source, or dynamic, by assignment to an identifier that contains a file name at open time. Microsoft permits path names, but does not search directories for data files. Micro Focus and DRI allow only drive:filename—

only files in the current directory of each disk drive may be processed.

Micro Focus and DRI provide identical support for sequential and relative files. Variable-length records are supported only in LINE SEQUENTIAL files, in which each record is terminated with a CR/LF sequence. In relative files, although each record is the same length, each is also terminated with this sequence if it is an active record, and with LOW-VALUES (binary zeros) if the record has been deleted.

Microsoft sequential files contain variable-length records only, with a leading length word on each record in plain SEQUENTIAL organization and a terminating CR/LF in LINE SEQUENTIAL organization. The functional equivalent of fixed-length sequential files, with no appendages to each record, is provided by relative files under sequential access mode. ADVANCING and other spacing options are allowed only for files assigned to the printer, making it inconvenient to produce formatted disk files for subsequent printing.

DRI COBOL supports indexed files through the Access Manager utility, but the interface to that utility is normally totally transparent to the programmer. The compiler accepts normal COBOL indexed I/O syntax and automatically generates calls to the primitive data and index functions provided by Access Manager. Alternately, the program may contain explicit calls to these functions. Unlike the Display Manager features, they are well documented, and they operate at an unusually low level for COBOL applications. For example, in order to add an indexed record to a file using Access Manager explicitly, the following sequence of primitive functions must be called:

1. Determine if the key exists in the primary index; if found, go to error procedure.
2. Determine the next available data record number.
3. Write the data record to that record number.
4. Write the key to the index file, specifying the number of the data record.
5. Repeat step four for each alternate key.

In comparison, typical COBOL syntax for accomplishing this task might be:

```
WRITE UPDATE-RECORD,
   KEY IS ID-NUMBER,
   INVALID KEY GO TO ERROR-10.
```

Overall, Access Manager provides no advantage over standard COBOL

syntax. The DRI COBOL user may be forced, however, to use the low-level facilities of Access Manager because standard COBOL syntax does not always work. Attempting to rewrite an indexed record after changing an alternate key, a perfectly legal operation according to the manual, fails with an invalid key error. DRI is aware of this situation; however, until it changes, indexed file operations are not fully supported.

Documentation for the structure of the file's data portion is another problem with the DRI indexed file facility. This structure is described as being physically the same as a relative file, and a recovery procedure based on this fact is outlined. This is true for Micro Focus files, but DRI files have a completely different structure and the recovery procedure does not work (this is a section of Micro Focus documentation that should have been deleted from the DRI manual). Access Manager does, however, provide a utility for recovering files with damaged indexes.

Using the low-level Access Manager facilities, the number of alternate keys per file is unlimited. For COBOL syntax, the limit is stated as 80 alternate keys per file, the same as for Micro Focus. Whether this is indeed the case or whether it is another mistake in the documentation was not determined.

Microsoft documentation states no limit for the number of alternate keys per file; technical support personnel claim that it is in fact unlimited. Of course, practical limits will be imposed by the disk space available for the index file. The indexed file structure is not documented, but a stand-alone utility is provided to allow indexes to be rebuilt from data records.

Before running a Microsoft COBOL program that performs indexed file I/O, the user must load a resident ISAM (Indexed Sequential Access Method) utility. This program apparently handles indexed files for a variety of Microsoft products, meaning that the files are portable between languages. This step is inconvenient when compared to either the Micro Focus or DRI compiler, which automatically load the required routines at runtime.

Table Handling. All three compilers provide standard level 2 implementation of tables, including indexing, subscripting, and linear and binary search. Micro Focus and DRI permit as many as 49 dimensions per table instead of the standard three. In practice, the number of dimensions is something less, limited by the size of the Data Division (the space in the Procedure Division for

generating code for multiple indexes), but more so by the programmer's ability to conceptualize tables of more than a few dimensions. Microsoft programs are slow in table handling, as indicated by the Sieve benchmark, and indexing yields only a slight improvement in speed over subscripting.

Library. The level 2 Library module provides for copying source files from a number of libraries into a main file during compilation, with text replacement. All three compilers offer these capabilities. To Microsoft, a library is a subdirectory, but for Micro Focus and DRI, it may only be the current directory on any of the disk drives. Also, Microsoft allows the user to specify search paths for copy files; as with other file operations, Micro Focus and DRI provide no path support.

Debug. ANSI Debug is meant for a batch COBOL environment. It is not very useful on an interactive system. Debugging facilities defined by ANSI include debugging lines that are compiled or treated as comments, depending on the state of a compiler or runtime switch; USE FOR DEBUGGING procedures that are executed when accessing specified files, data items, or procedures; and DEBUG-ITEM, a predefined data area that contains information about the entity causing the USE procedure to be activated. Micro Focus and DRI provide all of these, but no more. Micro Focus also offers an optional, source-oriented debugger called ANIMATOR. The DRI compiler apparently cannot produce the symbol tables required for ANIMATOR.

Microsoft supports only the debugging lines. But this compiler provides debugging extensions within the source language and a symbolic debugger that more than compensate for the missing ANSI facilities. The extensions are an EXHIBIT statement that is similar to the unformatted display statement but that also shows the name of the data item for which the value is being displayed and TRACE statements to turn on and off the display of each paragraph name reached by the flow of execution. The latter is similar to TRON and TROFF in BASIC, but is possibly more useful because only the procedure entry points are shown, not all of the statements in the path of execution. However, the TRACE capability does not show the branches through an IF statement.

For debugging, a Microsoft COBOL program is executed by the interactive debugger instead of the runtime system. Source statements are referenced by line number, so a hard-copy compilation listing is required. Data values may be displayed by name or address, in hexadecimal or character format, but computational items are displayed as is, with no conversion to display format. Values of data items can be changed, except index names and subscripted variables, which is unfortunate, as these are often the most useful modifications made during a debugging session. As many as eight breakpoints may be set and the program may be executed step by step, one or more statements at a time. Unlike other symbolic debuggers, this one permits changing the sequence of program execution.

Inter-Program Communication. Dynamic loading is the basic mechanism for calling subprograms in all three compilers. When a CALL statement is executed, the subprogram named in the literal or data item is read from disk, unless it is already in memory. Full level 2 memory management is provided, allowing the user to test for insufficient memory space at call time and cancel loaded subprograms to make room for others.

Micro Focus and DRI also permit linking COBOL main programs or sub-

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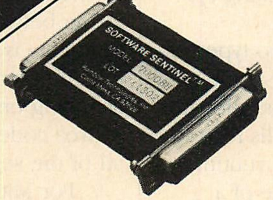

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programs to the runtime system using a linker called BUILD, which is provided. An application built in this way may be invoked directly from DOS instead of through the runtime system. Microsoft allows only assembly language routines to be linked. The runtime system and debugger modules are provided in object form, to be linked with the user's object modules by means of the standard Microsoft LINK program (which is also provided with the package).

Microsoft provides the important capability to chain one program to another main program that is written in any language supported by DOS. Data may be passed to the new program and it may chain back as well. For non-COBOL programs, the data is passed in the DOS parameter area in the program segment prefix, so only 128 bytes may be passed. The documentation is unclear as to whether COBOL programs may receive more than this through a chain. This mechanism is one way to pass command line parameters to a COBOL main program: the program is constructed as if DOS were chaining to it. The other way is by calling a subprogram provided in the runtime system.

Microsoft's assembly language interface is straightforward and well documented. Several routines are built into the runtime system; besides returning command line parameters as mentioned above, they perform functions such as determining the existence of files, renaming and deleting files, and passing a completion code to the operating system on program termination.

Micro Focus supports two types of assembly language calls. One is the same as for COBOL programs, allowing either dynamic loading or calls to resident routines linked into the runtime; the other is static only, to one of a number of routines contained in a file that must have been built into the runtime system. DRI provides the same capabilities, but omits part of the documentation necessary for implementing the second method. Both provide more than 20 built-in routines for performing low-level system functions such as peeks and pokes, single-character console I/O, and reading from or sending to hardware I/O ports.

Segmentation. Like subprogram calls, segmentation provides a means of executing programs larger than 64KB. In the context of COBOL, *segment* means a section of code defined by the programmer; it has no relation to the concept of a hardware segment in the 8088 memory space. A program may be divided into fixed segments, which are memory-resident, and independent segments, which are read in as required. All three compilers provide ANSI level 2 segmentation support: segments need not be contiguous or in ascending sequence by segment number, and the division between fixed and independent segments is easily modified. This permits fine tuning the overlay structure by changing only one statement in the source code, instead of renumbering all of the segments.

For Micro Focus and DRI, when a segmented program is linked into the runtime system, the user may specify which independent segments are to be included in the resulting load module. These segments are then loaded with the fixed segments when the application is run, providing even more control over the overlay structure.

Sort. All three compilers support standard ANS syntax for SORT and MERGE statements. Microsoft is the only compiler that allows files in USING and GIVING clauses to have any organization, in effect providing an automatic copy operation to and from sequential organization before and after the sort. Micro Focus and DRI permit only sequential files in USING and GIVING phrases, but of course any type of file may be sorted if the programmer pro-

vides an input procedure to read the file and feed the sort, as well as an output procedure to receive sorted records and write them out to any kind of file.

Microsoft is fast in sorting, but at the expense of disk space. The test on the 100KB file (1,000 records of 100 bytes each) ran out of space on a 360KB floppy disk and had to be run with the input file on a different drive than the work and output files. Processing on two floppy-disk drives is slower because one has to be shut down when the other is started, resulting in pauses for the motor to come up to speed. On one drive, there is a good chance that the motor is still spinning from the previous access. As shown in table 3, Microsoft COBOL performed better on two drives than the other compilers did on one, attesting to its efficiency.

MORE CHOICES?

Microsoft COBOL is a good value for the price. Even if its high-level certification is stretching the point, it offers a good range of features and its documentation is the best among the five compilers reviewed thus far. Other strong points are its fine performance in sorting and indexed file I/O, its complete DOS path support, and its size—small enough to be practical on a floppy-disk-based system. On the other hand, its strange way of assigning files and its inability to link entire applications into one load module are minor annoyances, and the poor performance in internal operations and unfriendly full-screen interface are major disappointments. Overall, it earns only a lukewarm recommendation.

Micro Focus Level II COBOL is an elegant product. Its capacity for quickly producing testable intermediate code and still generating efficient native code for production use provides for highly convenient development and efficient finished applications. The screen interface is excellent, if slightly tedious to implement with the bare compiler, and performance in internal operations and file I/O is more than adequate.

But this compiler does have some rough spots. The most serious is its inability to navigate DOS paths to find files in subdirectories other than the current one on each drive. Another is error handling, particularly the erratic behavior caused by some errors. This, however, is not a design problem and probably will be fixed. At more than double the price of the other two high-level compilers and fifty percent more than Realia and Ryan-McFarland, is Micro Focus really that much better? It's a close call, but remember that its final price is higher still with the addition of a debugger and screen generator utility, without which the compiler is usable but not the most convenient. As tested, Micro Focus is recommended for those budgets that can stand it, and if the error handling bug is fixed, it could be recommended enthusiastically.

Digital Research Level II COBOL is a not-ready-for-prime-time compiler, primarily because of the bugs in both the documentation and the indexed file module. The manuals appear to be preliminary drafts. This is true even of the documentation for Display Manager, a mature DRI product. The problems with indexed files are probably not the responsibility of Access Manager, another longtime DRI offering, but are more appropriately assigned to the interface between it and the compiler.

Assuming that these very real problems can be remedied, the DRI compiler is potentially an economical alternative to Micro Focus COBOL. The user must decide whether the current savings are worth a product that is like Micro Focus, yet omits some of that product's best features, solves none of its problems, and adds a few of its own. It provides much of the same power of the language and performance from the generated code, but it offers considerably less convenience in development, especially development of screen-intensive applications. Until the documentation and file I/O problems are solved, it is a dubious bargain.

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Ted Mirecki has a master's degree in computer science and 20 years of experience in information processing. As a corporate planner, he is responsible for developing decision support systems on a variety of hardware from microcomputers to mainframes.

LISTING 1: SORT.COB

```
 IDENTIFICATION DIVISION.
 PROGRAM-ID.    SORT.
*       SORT BENCHMARK

 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 SOURCE-COMPUTER.  IBM-PC.
 OBJECT-COMPUTER.  IBM-PC.
*
 INPUT-OUTPUT SECTION.
 FILE-CONTROL.

     SELECT IN-FILE
* FOLLOWING 2 LINES FOR MICRSOFT
           ASSIGN TO  DISK
           ORGANIZATION RELATIVE

* FOLLOWING 2 LINES FOR MICRO FOCUS & DRI
*          ASSIGN TO "B:FILE1.SEQ"
*          ORGANIZATION SEQUENTIAL

           ACCESS SEQUENTIAL.

     SELECT SORT-WORK
* FOLLOWING LINE FOR MICRSOFT
           ASSIGN TO  DISK.

* FOLLOWING LINE FOR MICRO FOCUS & DRI
*          ASSIGN TO "A:SORT.WRK".

     SELECT OUT-FILE
* FOLLOWING 2 LINES FOR MICRSOFT
           ASSIGN TO  DISK
           ORGANIZATION RELATIVE

* FOLLOWING 2 LINES FOR MICRO FOCUS & DRI
*          ASSIGN TO "B:FILE1.SEQ"
*          ORGANIZATION SEQUENTIAL
           ACCESS SEQUENTIAL.

 DATA DIVISION.
 FILE SECTION.
 FD  IN-FILE LABEL RECORDS ARE STANDARD
* FOLLOWING LINE FOR MICROSOFT ONLY
    VALUE OF FILE-ID IS "B:FILE1.SEQ"

    DATA RECORD IS RECORD-1.

 01  RECORD-1.
     05  SEQ-REC-WORD               PIC X(7).
     05  SEQ-REC-NUM                PIC 9(10).
     05  SEQ-REC-TAIL               PIC X(83).

 FD  OUT-FILE LABEL RECORDS ARE STANDARD
* FOLLOWING LINE FOR MICROSOFT ONLY
    VALUE OF FILE-ID IS "B:FILE2.SEQ"

    DATA RECORD IS RECORD-2.

 01  RECORD-2                       PIC X(100).

 SD  SORT-WORK
* FOLLOWING LINE FOR MICROSOFT ONLY
    VALUE OF FILE-ID IS "B:SORT.WRK"

    DATA RECORD IS SORT-RECORD.

 01  SORT-RECORD.
     05  SORT-REC-WORD               PIC X(7).
     05  SORT-REC-NUM                PIC 9(10).
     05  SORT-REC-TAIL               PIC X(83).
```

```
WORKING-STORAGE SECTION.
77  REC-LIMIT                   PIC 9999.
77  HALF-WAY                    PIC 9999.
77  COUNTER-1                   PIC 9999.
77  COUNTER-2                   PIC 9999.
    COPY TIMERDAT.

PROCEDURE DIVISION.
000-MAINLINE.
    PERFORM 100-WRITE-FILE THRU 100-EXIT.
    PERFORM 200-SORT-FILE  THRU 200-EXIT.
    STOP RUN.

100-WRITE-FILE.
    DISPLAY "Enter record count, 50 - 1000".
    ACCEPT REC-LIMIT.
    OPEN OUTPUT IN-FILE.
    COMPUTE HALF-WAY = REC-LIMIT / 2.
    MOVE HALF-WAY TO COUNTER-1.
    ADD  HALF-WAY 1 GIVING COUNTER-2.
    DISPLAY "Writing sort input, No. recs = ", REC-LIMIT.
    ACCEPT TIMER-START FROM TIME.
    PERFORM 120-WRITE-LOOP THRU 120-EXIT HALF-WAY TIMES.
    CLOSE IN-FILE.
    ACCEPT TIMER-END FROM TIME.
    PERFORM 2400-CALC-TIME THRU 2400-EXIT.
    DISPLAY ELAPSED-TIME.
100-EXIT.   EXIT.

120-WRITE-LOOP.
    MOVE "RECORD"  TO SEQ-REC-WORD.
    MOVE COUNTER-1 TO SEQ-REC-NUM.
    MOVE SPACES    TO SEQ-REC-TAIL.
    WRITE RECORD-1.
    MOVE "RECORD"  TO SEQ-REC-WORD.
    MOVE COUNTER-2 TO SEQ-REC-NUM.
```

```
    MOVE SPACES    TO SEQ-REC-TAIL.
    WRITE RECORD-1.
    SUBTRACT 1 FROM COUNTER-1.
    ADD      1 TO   COUNTER-2.
120-EXIT.   EXIT.

200-SORT-FILE.
    DISPLAY "Beginning Sort".
    ACCEPT TIMER-START FROM TIME.
    SORT SORT-WORK ON ASCENDING KEY SORT-REC-NUM
       USING IN-FILE GIVING OUT-FILE.
    ACCEPT TIMER-END FROM TIME.
    PERFORM 2400-CALC-TIME THRU 2400-EXIT.
    DISPLAY ELAPSED-TIME.
200-EXIT.   EXIT.

    COPY TIMERPRO.
```

CIRCLE NO. 136 ON READER SERVICE CARD

Drop-in Modules for C

Part 2

Each of these windows libraries offers its own definition of what a text-windowing package should do—some to a greater degree than others.

WILLIAM J. HUNT

This is part 2 of a series on tools libraries for use with the C language. Part 1 ("Drop-in Modules for C", William J. Hunt, June 1985, p. 100) reviewed general purpose tools libraries that provide access to DOS and BIOS services. Part 2 covers tools for managing multiple windows on the PC's display screen.

ILLUSTRATION • ANDY ZITO

The term *windows* is a hot buzzword in the microcomputer industry these days. But beneath the hype surrounding the word lies the question of practicality. Can an applications developer put a windows library to effective use? Unlike products such as IBM's TopView and Microsoft's Windows, the C windows libraries reviewed here do not provide an environment in which several applications can run concurrently and share the display screen. Instead they allow a single application to partition the display screen into windows and update these windows independently of one another.

Windows libraries, therefore, are not for users of applications programs but rather for the programmers who write the applications. Many PC applications are highly interactive—they need fast screen output for good response time and support for status lines, help screens, pop-up menus, and split screens for a good user interface.

The libraries tested differ in the features they supported and in the quality of the implementation of their features. The LRM Systems CRIOS package provides a minimum of function and documentation. Software Horizons' Building Blocks II (or Power Pack 4) covers a number of areas—a minimal set of functions to support windows is only one of its features. VSI-The Window Machine from Amber Systems provides a powerful, nearly comprehensive set of capabilities but lacks the documentation to make it usable. Vance Info Systems' C-lib implements the features of the Curses package developed in the UNIX environment. It too has powerful capabilities and inadequate documentation. Creative Solutions' Windows for C library provides a good balance between features and performance with documentation that is at least adequate.

All of the products reviewed support character output to windows but not dot graphics. Although some graphics applications may require windows capabilities, the extra overhead required for bit-map graphics often compromises performance. By limiting themselves to text mode windows, these libraries can provide reasonable performance for character-only applications.

Table 1 lists some general information about the windows libraries reviewed: price, version tested, features, and C compilers supported. Microsoft C refers to versions 2.03 and earlier that are based on Lattice C. At this time, none of the products supports version 3.0 of Microsoft C.

All the products tested provide adequate support for managing windows—creating, removing, resizing, and moving them. Most of the packages allow borders and other options to be specified for each window.

The Window Machine and C-lib allow the applications program to control when the screen is updated. A series of window updates could be made in memory and then the final result displayed. Display updating looked very crisp and attractive using this technique.

Table 1 also lists display output functions for single characters, strings, and formatted input. These functions should be equivalent to the C library functions **putchar**, **puts**, and **printf**, but with output going to one window instead of to the standard output.

In the same way, the library should provide equivalents for the **getchar**, **gets**, and **scanf** functions. These replacement functions should echo input to a window rather than to the entire screen. The absence of these input

TABLE 1: *Product Features*

	CRIOS	WINDOW MACHINE	BUILDING BLOCKS II	C-LIB	WINDOWS FOR C
VERSION TESTED	1.1	4.0	5.4	1.0	3.1
COMPILERS SUPPORTED					
Lattice	Yes	Yes	Yes	Yes	Yes
Microsoft	Yes	Yes	Yes	Yes	Yes
Computer Innovations	–	–	Yes	Yes	Yes
Mark Williams	–	–	Yes	Yes	Yes
DeSmet	–	–	Yes	Yes	Yes
Aztec C	–	–	–	–	Yes
Digital Research	–	–	Yes	–	–
SOURCE CODE INCLUDED	No	No	Yes	No	Partial
SUPPORT FOR ALL MEMORY MODELS	Yes	Small, see text	Small, large	Small	Small, large
FUNCTIONS OTHER THAN WINDOWS			Date/time, graphics, input verify	DOS/BIOS communications	
MANAGING WINDOWS					
Creating	Yes	Yes	Yes	Yes	Yes
Removing	Yes	Yes	Yes	Yes	Yes
Moving	Yes	Yes	Yes	Yes	Yes
Resizing	Yes	Yes	Yes	Yes	Yes
Clips output	Yes	Yes	Yes	Yes	Yes
Resolves conflicts	–	Yes	–	–	–
OPTIONS					
Borders	Yes	Yes	Yes	Yes	Yes
Line wrap	–	Yes	Yes	Yes	Yes
Auto-scroll	–	Yes	Yes	Yes	Yes
Auto-update	–	Yes	–	Yes	–
DISPLAY OUTPUT					
Single char	–	Yes	Yes	Yes	Yes
String	Yes	Yes	Yes	Yes	Yes
Formatted (**printf** equiv.)	Limited	–	Yes	Yes	–
CONSOLE INPUT					
Single char	–	–	Yes	Yes	–
String	Yes	–	–	Yes	–
Formatted (**scanf** equiv.)	Limited	–	–	Yes	–
UPDATE FUNCTIONS					
Scroll up/down	–	Limited	–	Yes	Yes
Scroll left/right	–	Limited	–	–	Limited
Delete to EOL	–	Yes	–	Yes	–
Del/ins char	–	–	–	Yes	–
Del/ins line	–	–	–	Yes	–
Highlight an area	–	–	–	–	Yes
Read char and attribute	–	Yes	–	Yes	Yes
DEBUGGING AIDS	–	Yes	–	–	–

Yes means that the product provides the feature in a generally useful way. Limited means that the product implements it in a way that has limited usefulness.

All of the vendors seemed to have a different concept of what a windowing product should do, judging from the wide discrepancy of features provided. For Building Blocks II and C-lib, windowing was just one feature in a larger set of functions.

functions is not a major disadvantage—they can be constructed using a single character input function that does not echo characters, and then echoing and clipping capabilities can be added by the user. The Windows for C package demonstrates this technique in one of its demo programs.

Also listed in table 1 are some functions for updating the contents of a window. C-lib is strong in this area. Highlighting part of a window is an important feature for many applications; only the Windows For C library provided this function directly. Reading back the characters and attributes for part of a window is another useful function: it allows the user to construct any of the other update functions. The Window Machine, Windows for C, and C-lib all include this feature.

Printf statements can be used with all these packages for debugging. Although it interferes with window output, **printf** is a handy alternate method of displaying debugging information when window output does not work properly. The Window Machine package provides some help in tracing calls to its library functions. It will display the parameters for each call and display its control blocks for each virtual screen, including window location and size and current cursor position.

Good documentation is essential to make a product's features usable. Table 2 rates libraries on the effectiveness of their documentation.

Clear, step-by-step installation instructions must be a part of good documentation. It should include a correct inventory of files on the distribution disks and identify those files needed for routine compiling and linking. Operating instructions should describe steps for compiling and linking C programs to use library functions.

The manual should explain the basic concepts behind the window functions. The following topics should be discussed in a good manual.

Defining and using windows. A series of function calls is usually required to define and write to a window. The manual should provide a concise example of the sequence of function calls needed to define and access a single window and more than one window.

Overlapping windows. What happens when the user writes to a window that overlaps another window? When one of the windows is removed, is the display updated to reflect the entire contents of the other window?

Coordinates. Are coordinates measured from a corner of a window or from the

TABLE 2: *Product Ratings*

	CRIOS	WINDOW MACHINE	BUILDING BLOCKS II	C-LIB	WINDOWS FOR C
DOCUMENTATION					
Installation	Fair	Poor	Good	Poor	Good
Operation	Poor to fair	Very poor	Fair	Poor	Fair
Topics	Poor	Very poor	Poor	Poor to fair	Poor to fair
Individual functions	Poor	Poor to fair	Fair	Poor	Fair
Overall quality	Poor	Very poor	Poor to fair	Poor	Fair
EASE OF APPLICATIONS DEVELOPMENT*					
Help screens	—	Easy	—	Easy	Very easy
Status lines	Easy	Easy	Easy	Easy	Easy
Pop-up menus	—	See text	—	See text	Very easy
Split screens	Easy	Easy	Easy	Easy	Easy
Rearranging windows	—	Easy	—	Feasible	Not obvious
Concurrent output to overlapped windows	—	Easy	—	—	—

**These ratings are based on the following criteria:*
Easy—the library provides directly applicable functions.
Feasible—some housekeeping is required by the applications program.
Not obvious—the library does not provide all the functions needed, and the documentation gives no clues to the techniques needed to implement a solution with library functions.
No rating—the library lacks some essential functions.

None of the products supplied documentation that fulfilled the need for detailed information. In most cases, once it was discovered how to use the library, implementing the functions that were supplied was easy.

corner of the screen? In which corner is the origin, and is the first row and column numbered 0 or 1?

Clipping and wraparound. Is text truncated when the right edge of a window is reached or does it wrap around to the next line? What happens when the bottom of a window is reached? Is the text truncated or are the contents of the window automatically scrolled upward?

Borders. How are borders around a window defined? Do output functions protect borders against overwriting? Is the border considered part of the window, or is the coordinate system's origin found inside the border?

Performance and storage management issues. Several libraries require some tinkering to get good performance; a library's manual should discuss options and techniques for achieving good performance. The manual should also explain how the library uses memory and how its performance is affected by the number and size of windows defined.

Each individual function should be described thoroughly, concerning both what it does and how to use it. Functions related to the one described or used with it should be listed. The documentation should state which DOS or BIOS calls the function uses.

The overall rating in table 2 describes how effective the documentation is in making the product usable. It combines the answers to two questions: does the documentation help the user learn the product quickly and without unnecessary aggravation? And does the manual serve as an effective reference as the user writes programs that use the library functions?

Table 2 also gives estimates of the value of each library for the sample applications discussed in the benchmark section below. The difficulty of using the library to implement each sample application was rated according to selected criteria.

BENCHMARKS

The sort of interactive applications for which a windows library is useful require fast screen output. An application whose response to keyboard input is marred by sluggish updating of the display is unlikely to be successful with customers or with in-house users. A good windows product must balance capabilities against performance. Several benchmarks were used to measure how well the products succeeded.

The first benchmark measured the speed of writing single characters and character strings. In the single-character test, the program set the cursor position

and then wrote 20 characters, repeating these actions 400 times to give reliable time measurements. In the string-output test, also performed 400 times, the cursor was positioned, and two 20-character strings were written.

Different applications require different styles of updating the screen. In some, rewriting the entire screen is the simplest solution when an update is required. The benchmark was modified to measure the time needed to update an entire 24-line-by-80-column window. The two results show the time needed when the screen is updated with a single function call and when the screen is updated with one call per screen row.

In other applications, it is natural to update the screen with a series of incremental changes. Another modification of the basic benchmark program measured three types of updates. The first test wrote 20 characters at the beginning of a line and then cleared the rest of the line. In the second test, 20 characters were deleted and 20 were inserted on a line. The third test measured the time needed to delete a line, insert a blank line, and write 20 characters to that blank line.

All tests were timed with three windows defined: the main 24-by-80 window, a 1-by-80 status window, and a 10-by-50 window overlapping the main window. The third window was used only to report timing results.

The number of windows did not affect the output speeds of any of the products tested. Some products performed better when smaller windows were used. All times were measured on an IBM PC with a color graphics display adapter. The times for some products improved when a monochrome display adapter was used.

Table 3 shows benchmark results for these tests and lists the size of each library's character-output program.

TABLE 3: *Benchmark Results*

BENCHMARK TESTS	CRIOS	WINDOW MACHINE	BUILDING BLOCKS II	C-LIB	WINDOWS FOR C
CHARACTER OUTPUT (secs/1,000 chars)					
Single characters	4.49	2.50	5.56	1.51	1.35
Strings	1.88	0.83	0.60	1.51	0.27
FULL-SCREEN UPDATE (secs/screen)					
Single write	–	0.82	0.73	0.59	0.41
Line-by-line	3.41	1.87	0.80	0.59	0.78
INCREMENTAL SCREEN UPDATE (secs/line)					
Write and clear to end line	–	.05	–	.05	–
Delete and insert chars	–	–	–	.24	–
Delete and insert lines	–	–	–	.07	–
SIZE OF CHARACTER OUTPUT PROGRAM	27KB	31KB	33KB	21KB	23KB

Each of the products varied widely in the performance it delivered. With several of the products it was possible to improve performance by delaying screen update until all editing of the window had been completed.

CRIOS

CRIOS (Console Reformatting Input-Output System), by LRM Systems, is a modest product at a modest price. It provides some window management functions and nothing else. A single .OBJ object file contains all the CRIOS functions; the distribution disk contains a version for each of the four memory models that Lattice C supports.

The 18-page manual documents the individual functions offered by the product but provides no information on how the windows work. Two short sample programs are included at the end of the manual and two longer source files are on the disk. None of the sample

files includes comments or is discussed in the manual.

Access to the CRIOS functions is through a single function named **crio** or its companion, **crios**. The two functions differ only in the format of their arguments. Both expect a control string as the first argument. The string is scanned for commands, some of which may require additional arguments. The mechanism is like the C library function **printf**, but the details are different.

Using the **crio** interface is convenient for some commands but very awkward for others. In the example below, the control string defines a 24-row-by-80-column window (L24.80), named W0, with origin at row 0, column 0, surrounded by a double-line border (U1.1 7.02). Because of the double-line border, the window coordinates start at row 1, column 1.

```
crio ("W0 L24.80 U1.1 07.2");
```

The next example shows one way to position the cursor at a specified row and column of a window. The desired row and column numbers must be embedded in the control string, which is an awkward restriction.

```
sprintf (s, "W0 P%d.%d",row,col) ;
crio (s) ;
```

The library includes functions for displaying strings, integers, and floating-point numbers, but not for displaying single characters. In the single-character output benchmark, a one-character string was built and the **crio** string output function was used. Performance was poor for single characters and only marginal for strings.

Text output is truncated when the right side of the screen is reached; it does not automatically wrap around to the next line. The manual describes a function for turning automatic scrolling on and off, but scrolling never occurred during testing. It seems to work only if carriage return and line-feed characters are embedded in the text.

Some of the formats chosen for the **crio** control string are a poor fit with C. The single quote ('), double quote ("), back slash (\), and null ('\0') characters specify different functions within strings. All of these characters must be represented by escape sequences within C strings; this makes writing these strings tedious and error-prone. A null character represents the end of a C string, so embedding extra null characters within strings is very dangerous.

At present, the CRIOS package has little to recommend it. It provides few capabilities, mediocre performance, and inadequate documentation.

VSI-THE WINDOW MACHINE

The demo for VSI-The Window Machine by Amber Systems indicates that this library can perform wonderful tasks, but writing useful programs with it requires a major learning effort.

The manual is nearly useless. It is poorly laid out and printed. The first section seems intended to sell the package, not to make it usable. Information on installing the library and compiling and linking programs is inadequate. Creating and using windows requires a sequence of function calls, and the manual does not discuss the sequence or explain the concepts the product implements. It describes what the library functions can do, but says little about how to use them. Individual functions are described, but no examples are provided. The function descriptions run together, so that individual descriptions are difficult to find.

The distribution disk contains an exerciser program that demonstrates the library's features. The manual lists

the source code for this program, which is quite long (40 pages) and lacks explanatory comments. It is a poor substitute for a proper manual.

The Window Machine library provides very powerful and useful window capabilities. It manages multiple virtual screens (the VSI in its name stands for virtual screen interface) that may be larger than the physical screen. Each screen has a priority assigned to it; when screens overlap, the library resolves conflicts so that the higher priority screen overlays the lower priority one. This makes help screens and pop-up menus easy to implement. Increasing the priority of a help or menu screen lays it over another screen. Lowering its priority makes the normal screen visible again with its original contents. The manual does not explain the priority mechanism very well and does not give an example of setting priorities; the user has to find the priority setting function.

Each virtual screen has a viewing window on the screen that can be smaller than the virtual screen. The library functions can provide automatic scrolling when the cursor moves past the window's edge. This is another powerful capability that is not properly described in the manual.

Performance depends upon how the library functions are used. Unfortunately, the manual does not discuss performance issues at all. I found functions to set the mode of operation by scanning the manual looking for a way to improve the library's performance. In the default mode of operation, the screen is updated as the window is updated. In the fast mode of operation, multiple updates can be made to a window before the screen is updated. The benchmarks in table 3 reflect operation in the fast mode. Operation in slow mode is dramatically slower. In the string-output tests, the slow mode worked 1½ times slower. In the single-character tests, the slow mode required 16.7 seconds to output 1,000 characters, compared to 2.5 seconds in the fast mode—almost seven times slower.

Program size is another vital topic not adequately addressed by Amber Systems. The character-output program used an assembly language function supplied on the distribution disk to statically allocate space for virtual screen images; this resulted in a 71,296-byte program. An alternate method of allocating space dynamically, which reduces the program size to 31KB, is mentioned in the manual but not in the context of using this method to manage memory

more effectively. The manual's description of this method (the **vinitmem** function) reverses the input arguments, resulting in puzzling program crashes.

The Window Machine library does not provide many functions for updating the contents of a virtual screen. It provides several functions to read characters and attributes back from the screen, however. These functions can be used to implement character and line deletion and insertion functions.

Only the small memory model is supported by the Window Machine. Source code is available for the C language interface functions used to create libraries for other memory models. Amber Systems sells the code for $99.95; it sells an OEM version for $295.00 that allows the interface to be customized to fit the display hardware. Finally, Lattice, Inc. and Lifeboat Associates offer $295.00 versions that include libraries for all four memory models that Lattice C supports.

The Window Machine is the only library of those reviewed that supports other languages, including Pascal, FORTRAN, COBOL and PL/1.

It appears that a lot of thought and effort went into implementing the Window Machine library. However, little thought and effort went into documenting it. This product shows promise, but for now it is a headache to use.

BUILDING BLOCKS II

The Building Blocks II (BB II) library is Power Pack 4 in the vendor's set of six library products called the C Power Pack. Building Blocks II covers functions for text windows, some graphics functions, date and time conversions, and input field verification. This review concentrates on the package's text window functions.

Instructions for installing and using the product are minimal but adequate. Libraries are provided for small and large memory models. All source code is provided so libraries for other memory models can be compiled. Because the small and large models are those most often used, this is an adequate solution. Source files are packed into a single archive file, requiring about ten minutes of unpacking time. The documentation provides minimal information on linking C programs with the Building Blocks II library.

Building Blocks II uses functions from the Building Blocks I library, which was reviewed last month. At $149, Building Blocks I is a fairly expensive prerequisite to using the Building Blocks II library.

Benchmark results for the Building Blocks II functions are puzzling. The string-output function is fast, but the single-character output function is so slow that it is useless for interactive applications. Building a one-character string and using the string-output function produce even slower results.

Because the Building Blocks II library provides no support for overlapping windows, it does not cover many of the sample applications in table 2. According to Software Horizons, version 6.0 will include functions to save and restore windows. With this addition, the package would be useful for applications such as pop-up windows.

The documentation assumes that the user knows a lot about windows and needs a minimum of help. The Building Blocks II manual provides no examples of text window functions. It relies on the Building Blocks I manual to explain topics such as screen attributes and coordinates. The operation of some window functions is not explained; the reader is referred to the description of similar functions in the Building Blocks I manual. The Building Blocks II distribution disk contains more than 50 header files, but the manual does not identify which header files are used for text window applications.

Like the Building Blocks I product, Building Blocks II uses function names with mixed upper- and lowercase letters. Version 3.0 of the MS-DOS linker and the linker supplied with the Digital Research C compiler distinguish upper- and lowercase letters in public symbols, so the mixture of letters can cause trouble. Another nonstandard practice is that of naming header files with .DEF, .DCL, and .RPL file extensions. Although this is inconvenient, it will not cause any serious problems.

The Building Blocks II library is the only product tested that includes full source code. The many files contain few comments, but they should nonetheless be useful for understanding what the library functions do and for making modifications.

The Building Blocks II library's window functions alone do not provide enough value to justify buying the package. The other capabilities in the Building Blocks II library may make it more attractive. With the additions planned for version 6.0, however, the product could become more useful.

C-LIB LIBRARY

Vance Info Systems' C-lib product covers three areas: general tools for DOS, BIOS, and PC hardware access; asyn-

chronous communications support; and multiple window screen output. It was not reviewed as a general purpose library in part 1 of this series because it was incomplete and lacked adequate documentation. This review will concentrate on its windowing capability. Unfortunately, C-lib's window support is not quite finished either.

The library implements an IBM PC version of the **Curses** package developed for UNIX systems. In the UNIX environment, Curses provides an efficient, terminal-independent screen interface for applications programs. Although terminal independence is not a concern for most PC-DOS programmers, **Curses** defines a powerful set of windows capabilities and can be a good model for a PC-based windows library.

Single-character and string-output speeds are adequate in C-lib. Full-screen updates are quite fast; only the delete and insert character test produces a long update time.

C-lib functions control copying the window image to the physical screen. This allows the applications program to tailor screen updating to fit the application. In the single-character output benchmark, the refresh function was called for every line of output rather than for each character. Some tailoring is necessary for good performance.

Program size for the character-output program is smaller than for any other program. Because the C-lib functions allocate space for window images during execution, actual memory requirements are higher, although still acceptable. The library supports only the small memory model.

One major implementation problem was encountered with the C-lib functions. Output to a monitor attached to an IBM Color Graphics display adapter produced an unacceptable amount of interference (snow) on the screen. A revised library, which should be available soon, has reduced the interference to an acceptable level.

C-lib's **Curses** library suffers from inadequate documentation. It includes no information on compiling and linking programs to use the library. Useful examples are in short supply and descriptions of individual functions are vague. The manual seems to assume that the user is familiar with the **Curses** library and has the UNIX documentation for those functions on hand.

With a fix for the screen interference problem, support for the large memory model, and adequate documentation, the C-lib library would be a very useful tool.

WINDOWS FOR C

Creative Solutions' Windows for C does not handle every window application, but it provides very good support for some applications (see table 3). It is a complete product for non-overlapping windows, and it can handle simple applications of overlapping windows, such as pop-up menus.

Library functions make it easy to read text files and display them in a window. With these functions, setting up a context-sensitive help system with help information stored on disk or in memory is no problem. A menu function provides similar support for pop-up menus. The only drawback is that the documentation does not illustrate either application clearly enough.

Benchmark results are quite good for single-character, string, and full-screen tests. The .EXE file is reasonably small, and, because Windows for C does not allocate space for window images, memory requirements are also reasonable. Unlike The Window Machine and C-lib packages, the default option settings for Windows for C produced good performance for all the tests.

The major limitation of Windows for C is that it does not resolve collisions between overlapping windows. Whatever is written to a window shows up on the screen even if it overwrites part of another window. The burden is on the user to save and restore windows that will be overlapped. This limitation is a sensible one; because of it, Windows For C requires little storage space and delivers good performance.

Windows for C does not provide enough support for incremental updating of windows. It does have some low-level functions that could be used to implement the insert-and-delete character and line functions, but the user must figure out how to do it.

The Windows for C documentation is marginal, but is clearly better than that for any other product tested. It depends heavily on several tutorial programs. The programs contain blocks of comments to explain what they do, but several of the programs are too long and complicated to be effective examples. The manual does not discuss the underlying concepts of the Windows for C functions, and its tutorial organization is ineffective for reference information. Individual functions are described with UNIX-style manual pages. These descriptions are adequate but lack usage examples. Functions are indexed alphabetically and by category.

According to the manual, Windows for C can run under IBM's windowing system, TopView. It does not makes full use of TopView's capabilities; it just writes to the screen in such a way that the applications program can run in a TopView window.

Although the documentation is somewhat disappointing, on the whole Windows For C is a well-implemented package. It provides genuinely useful capabilities and performs well.

TIME AND EFFORT

A windows library package can provide several useful functions to an applications developer who understands how windows could help his work and who can spend a few days experimenting with the package.

Every product tested had its own definition of windows—what a windowing package should do and how it should handle problems such as overlapping windows and updating the screen. Documentation of individual functions was incomplete and did not include examples of use. Only the manual for Windows for C described the sequence of function calls needed to set up and use multiple windows.

The Windows for C library provides good support for status lines, help screens, and pop-up menus. It allows overlapping windows but provides no help in resolving collisions. The library functions support updating an entire window but do not support incremental updating in any form.

The C-lib package provides a full implementation of the Curses package developed for the UNIX environment. The library does not automatically resolve collisions between overlapping windows but has extensive support for full-window and incremental updating. The documentation is inadequate, and display updating produces an unacceptable amount of interference. When these problems are corrected the C-lib package will be very useful.

The Building Blocks II (or Power Pack 4) package covers a number of areas: graphics, verification of input fields, date and time processing, timing support, and windows. The windows support is basic, but overall the package offers many functions. Like its fellow Software Horizons' product, Building Blocks I reviewed in part 1 of this series, Building Blocks II is long on functions and short on explanation.

The Window Machine provides powerful support for overlapping windows. Pop-up menus and help screens are especially easy to implement using window priorities. The powerful features do, however, have a price: per-

formance is satisfactory but not as good as that of the simpler products, and the memory requirements are higher than for other products. The user must learn a great deal in order to use this package well; the manual and the demo program provide little help.

The CRIOS package implements only the basic window capabilities. The **printf** style interface it uses for all library functions is convenient for some functions but clumsy for others. The manual is short and not very useful. This product needs more work.

None of these windows packages is aimed at novice C programmers. Neither is any one of them suitable for an applications programmer who needs tools that can be put to work immediately. The documentation shortcomings of these products can be cured if the vendors invest the time and effort to finish their job.

Building Blocks II (Power Pack 4): $149
Software Horizons, Inc.
165 Bedford Street
Burlington, MA 01803
617/273-4711
CIRCLE 301 ON READER SERVICE CARD

C-lib: $145 (introductory price); $195 after July 31, 1985
Vance Info Systems
2818 Clay Street
San Francisco, CA 94115
415/922-6539
CIRCLE 338 ON READER SERVICE CARD

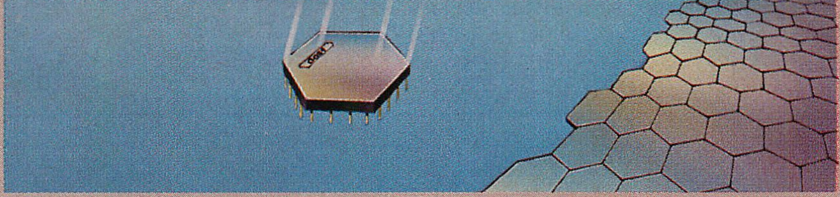
CRIOS: $49.95
LRM Systems
4438 Donna Drive
Cleveland, Ohio 44143
216/383-9831
CIRCLE 302 ON READER SERVICE CARD

VSI-The Window Machine: $59.95
Amber Systems, Inc.
1171 S. Saratoga-Sunnyvale Road
San Jose, CA 95129
800/538-8157 ext. 824; in California, 800/672-3470 ext. 824
CIRCLE 303 ON READER SERVICE CARD

Windows for C: $195
Creative Solutions
21 Elm Avenue
Richford, VT 05476
802/848-7738
CIRCLE 304 ON READER SERVICE CARD

William J. Hunt is writing a book on software tools and C programs that illustrate real-world functions. Titled The C Toolbox, *the book is scheduled to be published later this year by Addison-Wesley.*

FUNCTIONS AND USES OF A WINDOWS LIBRARY



Like other buzzwords in the personal computer world, *windows* does not have the same meaning for everyone. The products reviewed here did not agree on what a windows library should do—they provide different features and use different terms in describing these features. Therefore, a definition of a windows library is in order.

A windows library is a practical tool so it is appropriate to define it in terms of practical uses. Some products may not support all of the applications described below, but the list illustrates which features are needed and the practical use of those features.

In the first place, a windows library must provide useful functions for writing to each window. Since each window can be thought of as a small display screen, the same kinds of output functions that are useful for normal screen output are needed for window output.

Additionally, a windows library should provide functions for saving and restoring a screen. On-line help screens are increasingly common in applications. Typically, one function key is dedicated to the help function; whenever it is pressed, the current display screen is replaced by a screen of information on using the program. After reading the help screen, the user presses a key and the program restores the previous screen to the display.

Some applications require that the screen be split into multiple windows. Many programs display status information and error messages in a dedicated status area. With a windows library, two windows can be defined, one for the normal display area and another for the status area. Library functions for screen output should ensure that writing to one window does not affect the contents of other windows. Keeping screen output within the bounds of the specified window, or *clipping*, is an essential part of a windows package. Clipping also functions to limit *scrolling*, or clearing the screen to the specified window.

Pop-up menus are becoming common. Such menus appear in place of part of the normal display until a selection is made; then the original screen display is restored. Support for these dynamic menus requires saving and restoring the original screen contents and clipping output as described above. It also requires a contrasting border to be displayed around the pop-up menu window. Highlighting a menu selection with a contrasting color or reverse video display is another common technique. Changing the screen attribute of part of a window without changing the characters written is a requirement in many applications of windows functions.

These applications have involved one window for normal display and others for special purposes. Some applications need more than one window for normal display. For example, a text editor might operate on two files with a window for each.

The Apple Macintosh has popularized an interface style with overlapping windows that can be moved about the screen and changed in size without destroying their contents. This dynamic use of windows requires special functions. In addition, the windows package must preserve window contents and provide a mechanism for redrawing all windows after they are rearranged.

Some applications of overlapping windows, such as pop-up menus, write only to a single window. In this case the windows functions need not resolve collisions between windows. Other applications require concurrent output to two overlapping windows. A communications program might continue to display received characters even if part of that window is overlapped by a pop-up menu window. To support these applications a windows package should resolve conflicts between overlapping windows.

—WJH

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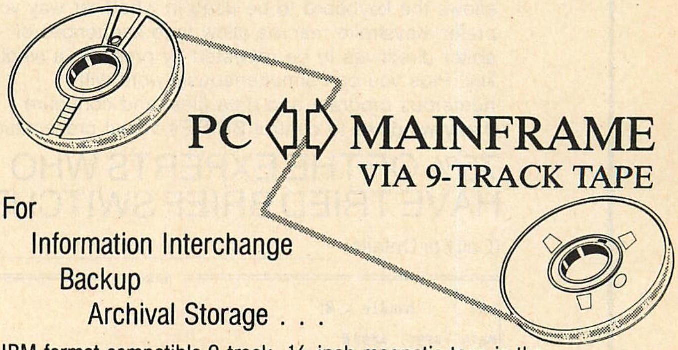

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A Change in Command

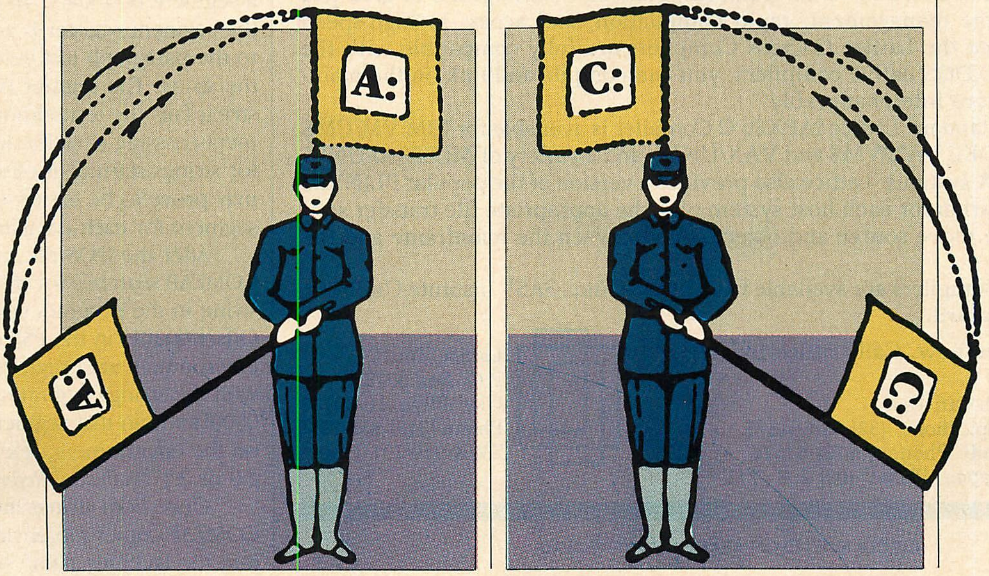
A program called COMZAP fixes a bug in DOS and permits relocation of COMMAND.COM to a VDISK or a fixed disk.

EDWARD NISLEY

Producing a microcomputer operating system, like any other complex project, requires communication—among designers, programmers, documentation writers, and program testers. And despite the efforts of all concerned, the right hand does not always know what the left hand has been doing until it is too late. PC-DOS provides a classic example of this phenomenon in its SET COMSPEC command; the resulting bug, however, is fixed easily by the program offered here.

The DOS command processor is loaded from A:\COMMAND.COM when the PC is booted from a floppy disk. A portion of COMMAND.COM remains resident in RAM until the system is turned off, but a transient portion may be overwritten by a program requiring a large amount of RAM. Moreover, when the large program terminates, the resident part of the command processor determines that the transient part has been destroyed and reloads it from the diskette file.

The DOS 2.0 and 2.1 manuals explain that DOS inserts the disk, path, and file name of the COMMAND.COM file it used during the initial boot process into the command processor's environment. Whenever the transient part is overwritten, DOS is supposed to use the environment string to locate COMMAND.COM for the reload. If the PC is booted from drive A:, the initial setting of the environment string is A:\COMMAND.COM.



SET COMSPEC allows changing of the string describing the location of COMMAND.COM, so that it can be put on a VDISK or fixed disk, eliminating the need to keep the boot floppy disk in a drive A:.The new string is specified by entering the command SET COMSPEC=C:\COMMAND.COM, where C:\ specifies that COMMAND.COM is in the root directory of drive C:. But the programmer writing the resident part of the command processor must not have known about this, because regardless of what is entered using SET COMSPEC=, DOS stubbornly expects to find A:\COMMAND.COM. (This bug exists only in DOS 2.0 and 2.1; it is fixed in DOS version 3.0.)

A little detective work with DEBUG reveals that the string DOS uses is located not in the environment, but somewhere deep within DOS. COMZAP.ASM (listing 1) is a utility program that finds that string and "zaps" (changes) the file name using the string specified by SET COMSPEC=. It works equally well with COMMAND.COM on a VDISK or a nonbootable fixed disk. Any subdirectory on any fixed disk or VDISK may be specified as the location for COMMAND.COM.

Because the command processor is loaded after any device drivers are installed and after the disk buffers specified in CONFIG.SYS are allocated, the address of the string is not fixed. The first character of the string always has an offset address ending in 9, regardless of its segment address.

COMZAP.ASM uses a three-instruction loop to search for the leading A character. It tests only bytes at offsets ending in 9, thereby testing only 4,096 bytes of the 64KB in each segment. The loop preincrements the pointer register, so when A is found the register contains the correct address.

But simply searching for the string "A:\COMMAND.COM" at an offset of xxx9 is not sufficient because several copies of that string may be present in RAM simultaneously. For example, if COMZAP.COM is on a VDISK, at least five strings exist: one in DOS, two in COMZAP.COM on the VDISK, and two in COMZAP running as a program. In addition, one string can exist in the copy of the environment in the PSP of any program loaded before the COMSPEC was changed. (Murphy's Law assures that at least one of those strings will begin at offset xxx9....)

The DOS string, however, is always preceded by a byte containing binary 0. A few lines of code reject any A without a 0, thus eliminating the strings in VDISKs and programs. The final test compares the characters following A with the rest of the expected string. The first string to meet all three criteria is presumed to be the real thing.

The string comparison operations fail without warning if the string crosses a segment boundary. To prevent this, the segment register is adjusted to point to the paragraph just before the start of the string. The register is restored if the string fails the test. Although the segment-crossing situation happens only for strings starting at offset FFF9H, it may prove to be easier to adjust the segment for each comparison.

After the DOS file string is located, COMZAP searches for the COMSPEC= string in the program environment area. Offset 002CH in the PSP contains the environment area segment address, with the strings beginning at offset 0000H within that segment. For details on the environment, refer to the DOS 2.0 or 2.1 *Technical Reference Manual*.

Once both strings are located, COMZAP copies the environment string into the DOS file name string. DOS ap-

pears to allow as many as 38 characters for the file name and the name must be followed by a byte containing a binary 0. If deeply nested subdirectories are used, take heed: COMZAP will truncate the file specifier at 39 characters to avoid overwriting DOS data. If this occurs, the resident part of the command interpreter will be unable to reload the transient part and the PC will become irretrievably hung.

With a working version of COMZAP ready, add the following two lines to the AUTOEXEC.BAT file:

```
SET COMSPEC=C:\COMMAND.COM
COMZAP
```

Make sure that the C: disk has a copy of COMMAND.COM in the root directory at all times or the PC will insist on "Insert COMMAND.COM disk in drive A:

DOS always attempts to reload COMMAND.COM from the boot disk.

and strike any key when ready" forever. (Since this message was not patched, DOS appears to be looking for COMMAND.COM on A:, even though it is actually searching on C:.) At this point, it is not possible to copy COMMAND.COM to C:, therefore, rebooting is the only way out.

If a fixed disk has COMMAND.COM located at the end of a multilevel directory tree, put the complete path needed to locate it in the SET COMSPEC= statement. For example:

```
SET COMSPEC=C:\PROGRAMS\DOS20
  \COMMAND.COM
```

The drive letter always should be included so DOS searches the correct disk. If it is omitted, DOS assumes that the COMSPEC string refers to a subdirectory on the current disk.

During the initial cold boot DOS computes a checksum on the contents of the COMMAND.COM file. The COMMAND.COM file specified using COMSPEC and COMZAP must be a direct copy of the COMMAND.COM used to boot the PC. If it is not identical, DOS will refuse to reload the transient part. This problem surfaces if a patched version of COMMAND.COM is booted with a "vanilla" version.

Edward Nisley is an independent microcomputer consultant in Poughkeepsie, New York.

LISTING 1: COMZAP.ASM

```
        page    76,132
        title   COMZAP.ASM

;---------------
; Program to force DOS 2.0 and 2.1 to reload COMMAND.COM
;  using the file name specified by SET COMSPEC=
; Particularly useful with VDISKs and non-bootable
;  fixed disks.
;
; The DOS 2.0 and 2.1 SET COMSPEC= command does not work as
;  documented. DOS will always attempt to reload COMMAND.COM
;  from the root directory of the disk drive used during
;  system initialization (the boot disk).
;
; This utility finds the string A:\COMMAND.COM in DOS
;  and replaces it with the file name set by SET COMSPEC=
;
; How it's done:
;  The BIOS memory-size interrupt determines the
;   range of RAM searched for the string.
;  The string A:\COMMAND.COM always starts at an
;   offset address xxx9, with a binary zero byte at
;   offset xxx8 just preceding it.  These observations
;   are used to distinguish the true DOS file name from
;   the string elsewhere (as in the program .COM file
;   a VDISK or the program as loaded in RAM)
;  Offset 2C in the PSP contains the segment address of
;   the environment area passed to this program. The
;   COMSPEC= string is located within the environment.
;  The COMSPEC= string is copied to the DOS string area
;   and displayed on the screen as it is being copied.
;  If the COMSPEC= string is too long, your PC is dead!
;   The string is truncated to fit the largest space
;   available, which means that it cannot be used to
;   reload the command interpreter.  Power-off time!
;
; Assumptions:
; - DOS 2.0 or DOS 2.1
; - Power-on boot drive is "A"
; - You have enough RAM in your system that the
;   string is not in the last segment.  The last segment
;   is not checked, except in 64K systems.
; - The SET COMSPEC string is not too long.  The maximum
;   length is one less than the number defined in cspecmax.
;
; Exit:  DOS function 4CH is used to pass a return code
;  code 0 = success!
;  code 1 = DOS file name string wasn't found
;  code 2 = COMSPEC string wasn't found
;  code 3 = COMSPEC string was too long, truncated
;

        page
;---------------
; hocus pocus to start up the assembler
;  and get the addresses correct for a .COM file

comseg  segment 'codeseg'
        assume  cs:comseg,ds:comseg,ss:comseg,es:comseg

comzap  proc
        org     100H

start:  jmp     around

;---------------
; The file name we are trying to find.  The leading
;  OFFH byte ensures that this file name isn't preceded
;  by a binary zero.  This prevents incorrect matching
;  when Murphy puts it at the correct offset.

        db      OFFH
bootID  db      'A'             ; the normal boot disk
CCstr   db      ':\COMMAND.COM' ; last part of string
CCstr_l equ     $-CCstr         ; string length
;---------------
; The COMSPEC= string header in the environment area

specstr db     'COMSPEC='
specstr_l equ  $-specstr        ; string length

;---------------
; Various & sundry constants

FN_hexit dw     0009H   ; file name offset hexit

env_seg_at equ  002CH   ; address of environment segment

prt_chr equ     02H     ; DOS single-character output
prt_str equ     09H     ; DOS print-string function
quit    equ     4CH     ; DOS termination function

mem_sz  equ     12H     ; BIOS memory-size interrupt
dosint  equ     21H     ; DOS function interrupt

cr      equ     0DH     ; useful characters
lf      equ     0AH
term    equ     '$'     ; the prt_str terminator

;---------------
; A macro to simplify the DOS interface

DOScall macro   DOS_fn
        mov     ah,DOS_fn
        int     dosint
        endm

        page
;---------------
; Variables

FN_at   label   dword   ; seg:offset address of
```

```
FN_off dw       0        ; DOS file name string
FN_seg  dw      0

cspec_at label  dword    ; seg:offset of COMSPEC=
cspec_off dw    0        ;  string in environment
cspec_seg dw    0

cspecmax equ    39       ; longest string allowed
                         ;  includes trailing zero

last_seg dw     0        ; last segment to check


;---------------
; Messages

Msg0    db      'COMZAP:  a DOS fixit utility',cr,lf
        db      'Revised  4 April 85',cr,lf
        db      cr,lf
        db      'Searching for A:\COMMAND.COM...'
CrLf    db      cr,lf,term
Msg1    db      ' >> not found.',cr,lf
        db      " >> Remember that COMZAP.COM can "
        db      cr,lf
        db      ' >> be run only once per cold boot'
        db      cr,lf,term
Msg2    db      cr,lf
        db      'The DOS command interpreter will be '
        db      'reloaded from ',cr,lf
        db      '   ',term
Msg3    db      'Searching for COMSPEC= string...'
        db      cr,lf,term
Msg4    db      ' >> not found.',cr,lf
        db      ' >> Did you use SET COMSPEC=filespec'
        db      cr,lf
        db      ' >> before running COMZAP.COM?'
        db      cr,lf,term
Msg5    db      cr,lf
        db      ' >> WARNING:  COMSPEC string too long,'
        db      cr,lf
        db      ' >> DOS will not reload the interpreter'
        db      cr,lf,term

        page
;---------------
; Start of the program code
;
; Show some identification

around: cld                     ; set increment mode

        mov     dx,offset Msg0  ; show ID message
        DOScall prt_str


;---------------
; Get storage size and convert to segment address.
; Because the last segment may not be full, we will not
;  test it for the string.
; Because we are testing in units of 64K (full segments)
;  only the high-order hexit of the segment address
;  is useful in comparisons.
; 64K PCs (are there any left?) are special-cases.

        int     mem_sz          ; storage in 1K units
        mov     cl,6            ; shift MSB to bit 15
        shl     ax,cl
        and     ax,0F000H       ; isolate 64K seg hexit
        jz      oneseg          ; handle 64K machines
        sub     ax,01000H       ; set last segment
oneseg: mov     last_seg,ax


;---------------
; Search for the starting "A" in "A:\COMMAND.COM"
; The inner loop uses CMP to check the 4096 offset
;  addresses ending in the hexit 9 in each segment.
; The outer loop verifies inner-loop hits and ticks
```

```
;  the segment addresses at the end of segments

        mov     al,bootID       ; the test byte
        mov     bx,0000H        ; first segment address
        mov     es,bx           ;  into segment register
        assume  es:nothing      ; tell the assembler

CClp0:  mov     si,FN_hexit     ; get offset address
        sub     si,0010H        ; fix for pre-increment
        mov     cx,1000H        ; 64K/16 = # of 9s

CClp1:  add     si,0010H        ; tick offset pointer
        cmp     al,es:[si]      ; test the byte
        loopne  CClp1           ; loop if not equal


;---------------
; Inner loop ended:
;  if "not equal", the entire segment has been examined
;  without finding a qualifying "A", so go to next seg

        jne     nextseg


;---------------
; We've found an "A" at an offset xxx9
;  if it's preceded by a binary zero, look closer...

        cmp     byte ptr es:[si-1],00H
        je      testmore        ; hmm... looking good!

        page
;---------------
; The "A" doesn't pass muster, so continue with the
;  next byte in the segment.
; If CX is zero, all bytes have been tested,
;  so we must step to the next segment

        cmp     cx,0
        jne     CClp1
        jmp     nextseg


;---------------
; An "A" and binary zero have been located!!!
; Time to compare the strings.
; Save the current state, just in case it's a miss

testmore:
        push    si              ; save current offset
        push    es              ;   ... segment
        push    cx              ;   ... count
        push    ax              ;   ... test byte


;---------------
; Set the segment address to the paragraph just before
;  the string to avoid overrunning the segment boundary
; This is complicated a bit by the restricted nature of
;  the 8088's "general" registers

        mov     bx,si           ; get current offset
        mov     cl,4            ; convert to paragraphs
        shr     bx,cl
        mov     cx,es           ; add the segment
        add     bx,cx
        mov     es,bx           ; set in in seg reg
        mov     FN_seg,bx       ; save segment


;---------------
; Set up the offset addresses to the known string and
;  the candidate we just found
; The candidate offset is always FN_hexit by definition

        mov     di,FN_hexit     ; known candidate offset
        mov     FN_off,di       ; save offset
```

```
        inc     di              ; step over "A"
        mov     si,offset CCstr ; known string
        mov     cx,CCstr_l      ; ... its length

;---------------
; After all that, this is the string comparison.
; Registers are restored before the branch simply to
;  avoid a double branch.
; The CMPS operands are coded for human readability.
; Failure returns us to the inner test loop above.
; Success passes us to the COMSPEC= string search.

        repe    cmps    byte ptr ds:[si],es:[di]

        pop     ax      ; restore saved regs
        pop     cx
        pop     es
        pop     si

        jne     CClp1           ; no good, continue
        jmp     gotfile         ; swell, break out

        page
;---------------
; Outer loop ending...
; Didn't find the string in this segment
; Tick the segment until we've completed the search.
; Remember that the RAM in the last segment will not
;  be examined because the segment may not be filled
;  with RAM...
; A tidge more code would make the search complete.

nextseg:
        mov     bx,es           ; tick segment pointer
        add     bx,1000H
        mov     es,bx
        cmp     bx,last_seg     ; done?
        jbe     CClp0           ; nope, back to loops
        mov     dx,offset Msg1  ; present error message
        DOScall prt_str

        mov     al,1            ; return code
        DOScall quit

        page
;---------------
; Tah-DAH!  Found the DOS file specifier in RAM.
; Now we have to look for the COMSPEC string.
; Each string in the environment is terminated with a
;  binary zero.  The end of the environment area is
;  marked by two binary zeros.
; Note how the "general" pointer registers aren't...

gotfile:
        mov     dx,offset Msg3  ; say where we are
        DOScall prt_str

        mov     si,env_seg_at   ; points to env seg ptr
        mov     es,[si]         ; pick up segment addr
        mov     cspec_seg,es    ; save seg addr

findspec:
        mov     di,cspec_off            ; get offs addr
        cmp     byte ptr es:[di],00H    ; at end?
        je      nospec                  ; sigh, give up

        mov     si,offset specstr       ; test string
        mov     cx,specstr_l
        repe    cmps    byte ptr ds:[si],es:[di]
        je      gotspec                 ; kapow!

        mov     si,di           ; use right "general" reg
junkit: lods    byte ptr es:[si]        ; scan for end
        cmp     al,00H
        jne     junkit
        mov     cspec_off,si            ; set up pointer
        jmp     findspec                ; and try again
```

```
;---------------
; Didn't find a COMSPEC= string in the environment.
; Return to DOS with an error code.

nospec:
        mov     dx,offset Msg4          ; show a sign
        DOScall prt_str

        mov     al,2            ; set return code
        DOScall quit

        page
;---------------
; Found the COMSPEC= string in the environment area
; ES:DI now points to the start of the file spec string
; Need to get source in DS:SI and target in ES:DI
; Transfer the COMSPEC= string to the DOS file string
;  and display it as it is transferred.
; The trailing binary zero is transferred as well, to
;  overwrite any previous file name you may have
;  manually inserted into the DOS file string while
;  debugging this program...
; The string will be truncated to prevent stamping on
;  other DOS data following the file name area.

gotspec:
        mov     cspec_off,di    ; save offset

        mov     dx,offset Msg2  ; say what's happening
        DOScall prt_str

        mov     cx,cspecmax     ; max length allowed
        les     di,FN_at        ; DOS string address
        lds     si,cspec_at     ; COMSPEC string addr
xfer:   lods    byte ptr ds:[si]        ; COMSPEC char
        stos    byte ptr es:[di]        ; to DOS char
        cmp     al,00H                  ; hit the end?
        je      alldone                 ;  yup, quit
        mov     dl,al                   ;  nope, show it
        DOScall prt_chr
        loop    xfer            ; repeat for count
                                ; if fall through, error!

        mov     ax,cs           ; restore DS
        mov     ds,ax

        mov     dx,offset Msg5  ; tell about truncation
        DOScall prt_str

        mov     al,3            ; set return code
        DOScall quit


;---------------
; Done with transfer and display, return to DOS

alldone:
        mov     ax,cs           ; restore DS
        mov     ds,ax

        mov     dx,offset crlf  ; insert some space
        DOScall prt_str

        mov     al,0            ; good return code
        DOScall quit            ; and exit

        page
;---------------
; hocus pocus to turn off the assembler
;  and set up .COM starting address

comzap  endp
comseg  ends
end     start
```

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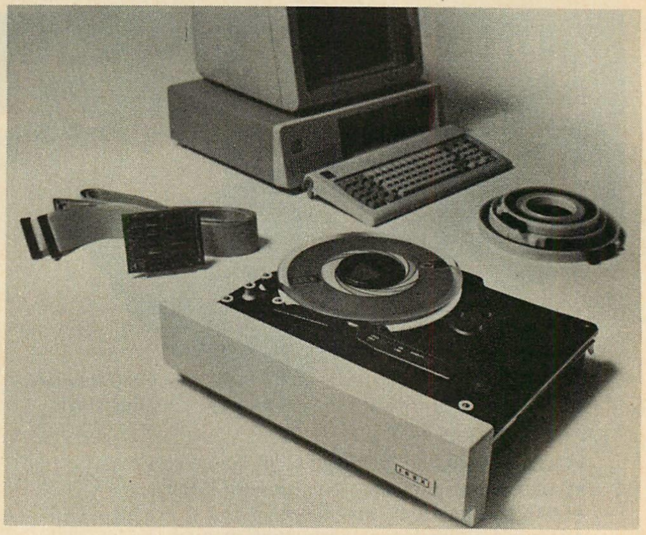

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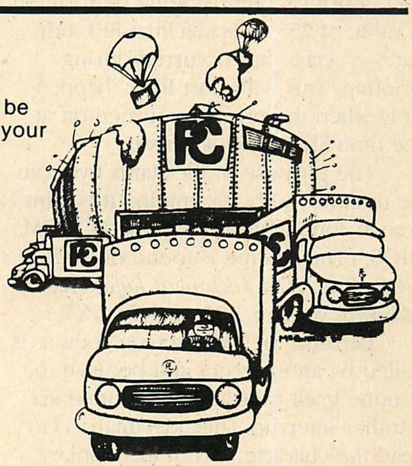

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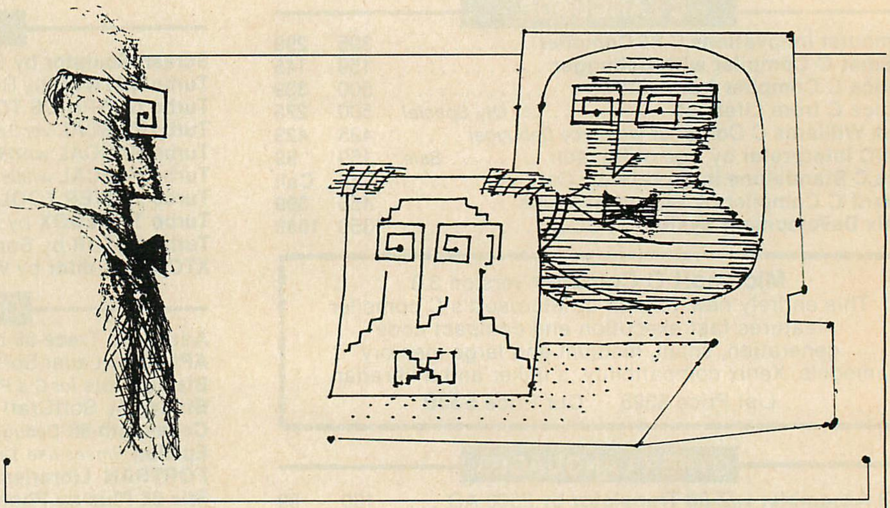
A Print Screen Switch

The otherwise convenient print screen command sometimes produces surprise print jobs; a routine can turn the feature off and on as needed.



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One of the most convenient features on the IBM PC is the print screen command. Hitting the Shift and PrtSc keys at the same time will print whatever is currently on the screen.

Sometimes, however, this convenience results in surprise hard copies because of the proximity of the Shift and PrtSc keys on the IBM keyboard. Hitting both of these keys accidentally when only the shift is desired is easy to do even for typists with the most accurate aim. Not only does this waste a page of paper (or a couple of expensive preprinted forms), but it also can jolt a programmer's concentration.

What is needed is a way to turn the print screen feature off. The *IBM Technical Reference Manual* reveals that the PC has a switch (actually just a location in memory) that the print screen command uses to tell whether or not the screen is currently being printed. This switch, located at address 0050:0000, is called the *status byte*.

If the status byte is set to 0, then no print screen is in progress; if it is set to 1, a print screen is being performed. A value of 255 (hexadecimal FF) indicates an error has occurred during printing. This will most likely happen only when the printer is turned off at the time Shift-PrtSc is pressed.

The purpose of the status byte can be understood by examining the print screen routine, located in the PC ROM BIOS. (The routine is found on page A-81 of the *IBM Technical Reference Manual*, version 2.02 or the PC/XT.)

Because the print screen routine is called by an interrupt and because the routine itself calls another routine via another interrupt (hexadecimal 10) to read the characters from the display, the print screen routine can interrupt itself. Although it is possible to turn off interrupts in the PC, this cannot be done by a routine, such as that for print screen, that itself uses interrupts. The status byte solves the problem by giving the print screen routine a way to determine if it would be interrupting itself.

The effect of all this is to prevent new print-outs of the display from being initiated during repeated presses of the Shift-PrtSc keys. If this were not done, holding the Shift-PrtSc keys down a little too long could result in a few dozen copies of the display.

Turning off the PC's print screen feature is as simple as setting the status byte equal to 1. Then, pressing Shift-PrtSc invokes the print screen routine, but when it checks the status byte it is fooled into thinking that *another* print screen is in progress, and it simply ends. The effect is that nothing happens.

Listing 1 is an 8088 assembly language program that will toggle the status byte from 0 to 1 or from 1 to 0 each time it is run. The print screen feature can be turned off and on as often as the program can be run.

To enter the program, type in listing 1 using a word processor (or edline) and assemble with IBM's Macro Assembler. Link the resulting .OBJ file, and run EXE2BIN to produce a .BIN file that can then be renamed .COM, ready to run. Ignore the warning about the stack given by the linker.

Figure 1 is a binary dump—that is, a list of the hexadecimal values that make up the program. These values can be entered and saved with DEBUG.COM if the user does not have access to an assembler. Enter the following command in order to start the debug program:

```
DEBUG PRTSC.COM
```

Ignore the warning, "File not found." To begin typing in the values shown in figure 1, enter

```
E 100
```

Some numbers in the following format will appear on the screen.

```
0900:0100 76.
```

The cursor will be positioned after the period. The value before the period will be what is presently stored at the location represented by the first eight numbers. These values will change.

Enter all of the hexadecimal values from figure 1, with one space separating each two-digit figure; do not type in the addresses on the left side. Press Return after all the values have been entered. The debug program's prompt (–) should appear. Entering

```
D 100 16F
```

should produce an exact replica of figure 1. Correct errors by entering

```
E <address>
```

FIGURE 1: *Binary Dump of PRTSC Values*

```
0915:0100  BA 2E 01 B4 09 CD 21 1E-B8 50 00 8E D8 80 36 00   :..4.M!.8P..X.6.
0915:0110  00 01 8A 1E 00 00 1F BA-52 01 B4 09 CD 21 BA 63   .......:R.4.M!:c
0915:0120  01 0A DB 74 03 BA 68 01-B4 09 CD 21 CD 20 50 52   ..[t.:h.4.MIM PR
0915:0130  54 53 43 20 31 2E 30 31-0D 0A 28 43 29 20 31 39   TSC 1.01..(C) 19
0915:0140  38 34 20 62 79 20 54 6F-6D 20 53 77 61 6E 0D 0A   84 by Tom Swan..
0915:0150  0A 24 50 52 49 4E 54 20-53 43 52 45 45 4E 20 69   .$PRINT SCREEN i
0915:0160  73 20 24 6F 6E 0D 0A 24-6F 66 66 0D 0A 24 00 00   s $on..$off..$..
```

If a user does not have an assembler, these values, which are the same as those produced by assembling PRTSC.ASM, can be entered using DEBUG.COM. program.

where <address> is one of the four-digit addresses to the right of the colon (in the left column of figure 1). Use the space bar to skip over to the incorrect value and type in the correction.

Before saving the program two registers must be set to tell DEBUG.COM the size of the program just entered. To set a register, enter R and the register name, then enter a value for that register. First, set the BX register to 0000. Enter R BX, press Return, then enter 0000 and press Return. Use the same steps to set the CX register to 0170. Enter R and press Return to verify that BX = 0000 and CX = 0170.

To save PRTSC.COM, enter W and press Return. A message should appear indicating that 0170 bytes are being written to disk. To quit the debug program, enter Q and press Return. Enter PRTSC to run the program.

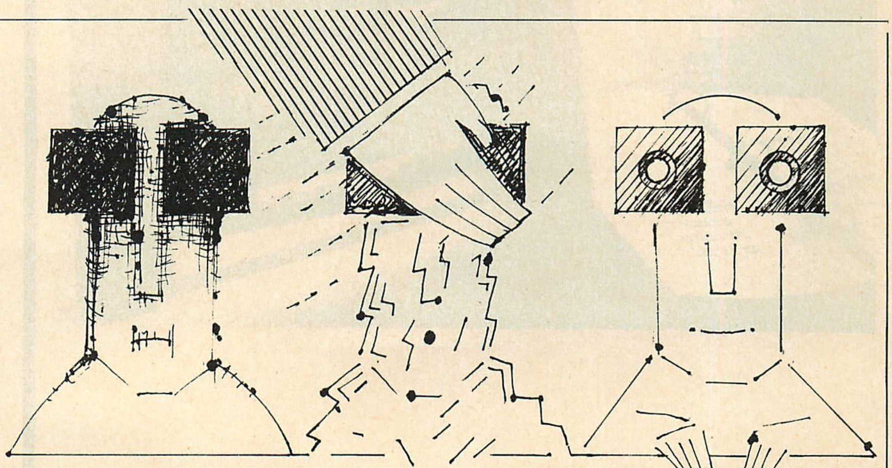
Tom Swan has written four programming books published by the Hayden Book Company. He is a consultant who runs his own business, Swan Software.

LISTING 1: PRTSC.ASM

```
page 60,120
title   PRTSC.ASM 1.01
;--------------------------------------------------------
;  Program      : Toggles print screen feature on/off
;  Version      : 1.01
;  System       : IBM PC DOS 2.00
;  Language     : IBM 8088 Macro Assembler
;  Author       : Tom Swan  P.O. Box 206  Lititz, PA 17543
;--------------------------------------------------------
;01-Aug-84 -ts- start date
;
cseg    segment para public 'CODE'
        assume  cs:cseg,ds:cseg
;
;----- Equates
;
cr      equ     13                      ;ASCII carriage return
lf      equ     10                      ;ASCII line feed
romdata equ     50h                     ;seg address of ROM BIOS data
prtstat equ     0                       ;offset of status byte
;
;----- Start of Program
;
        org     100h                    ;standard .COM entry point
prtsc:
        mov     dx,offset progid        ;print program identification
        mov     ah,9                    ;ah=DOS print string$
        int     21h                     ;call DOS to print string
        push    ds                      ;save data segment register
        mov     ax,romdata              ;set ds=ROM BIOS
        mov     ds,ax                   ; data segment address
        xor     byte ptr ds:[prtstat],1 ;toggle status on(0) / off(1)
        mov     bl,ds:[prtstat]         ;bl = current status
        pop     ds                      ;restore saved ds register
;
;----- Display status ON or OFF
;
        mov     dx,offset statstr       ;print status string
        mov     ah,9                    ;ah=DOS print string$
        int     21h                     ;call DOS to print string
        mov     dx,offset staton        ;prepare to print "on"
        or      bl,bl                   ;test current status
        jz      prtsc1                  ;jump if on (0)
        mov     dx,offset statoff       ;else print "off"
prtsc1:
        mov     ah,9                    ;ah=DOS print string$
        int     21h                     ;call DOS to print string
        int     20h                     ;return to DOS
page
;
;----- Strings
;
progid  db      'PRTSC 1.01',cr,lf
        db      '(C) 1984 by Tom Swan',cr,lf,lf,'$'
statstr db      'PRINT SCREEN is ','$'
staton  db      'on',cr,lf,'$'
statoff db      'off',cr,lf,'$'
;
cseg    ends                            ;end of segment
        end     prtsc                   ;end program
```

Alternative Licenses

Some companies are forsaking the standard shrink-wrapped licenses for innovative agreements that are more user-friendly.



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No contract is comprehensive. A good contract resolves major issues and provides guidance for the resolution of unforeseen or subsidiary issues. If a dispute concerning issues that are not specifically addressed in a contract reaches the litigation stage, a court may attempt to supply the details (although if too many details are missing, the court may find that no contract exists).

A court may look to the contract itself to interpolate the parties' intent, or it may look to external factors. One external factor that is often considered is the common method of dealing in the particular industry.

That a particular provision is the "industry standard" is also an argument frequently used in the negotiation of contracts. That argument is often made in support of computer software contract clauses that purport to eliminate any warranty of the function of the program and any significant liability if the program malfunctions. In this case, the "industry standard" is said to be the "shrink-wrapped" license.

Shrink-wrapped licenses, for the most part, are not models of fairness. For example, the IBM standard (see "The IBM Software License," Max Stul Oppenheimer, *PC Tech Journal*, July/August 1983, p. 149) attempts to limit the purchaser's rights to make back-up copies, to install the program on a hard disk, and to seek meaningful remedies for serious malfunctions or for damages arising from copyright infringement. While IBM might argue that its stake in the value of its reputation for integrity assures fair treatment regardless of what the formal contract says, the "standard" has been adopted with minor variations by companies that could not seriously make the same claim.

It is therefore doubly refreshing to see the emergence of an alternative to the standard. At least two companies offer software license agreements that indicate a shift toward fairness to customers: Mother Jones' Son's Software Corporation and Borland International, Inc. Borland's license provides:

> This software is protected by both United States Copyright Law and International Treaty provisions. Therefore you must treat this software just like a book with the following single exception. Borland International authorizes you to make archival copies of the software for the sole purpose of backing-up your software and protecting your investment from loss.

Borland defines "just like a book" as allowing use on any computer by any person as long as the software cannot be used by more than one person at one time. Borland does, however, limit its liability for breach of warranty, disclaiming all warranties except that the diskette and manual are free from defects in materials and workmanship (if the software does not perform as the manual describes, it is an interesting question whether the manual is free from defects in workmanship) and further providing that Borland will not be liable for lost profits or other commercial damage, "including but not limited to special, incidental, consequential or other damages." The quoted phrase raises the question of what liability is left if Borland disclaims damages "including but not limited to . . . other damages." At least Borland has taken a positive step with respect to the user limitations in software licenses.

Mother Jones' Son's Software Corporation has taken a similar approach to use restrictions. Its license begins by stating: "You agree to treat this software as if it were a book with the exception that you are granted the right to make backup copies." It then grants the right to the use of the software by multiple users on multiple machines (but only one user at a time). The warranty is somewhat broader than Borland's (warranting the software rather than the medium). Mother Jones' Son's limitation of liability provision has the same apparent intent as Borland's, although it is phrased more elegantly: " . . . just like any other self-help book, its value to you is what you make of it. No matter how badly it damages your life, or that of your customers and friends, we're not obligated to do anything about it."

Mother Jones' Son invokes a new standard in copy protection techniques as well: "Violate this agreement and our attorneys will see to it that life on earth as you know it is completely ruined."

The program license continues, however, " . . . you agree that, 30 days after you violate this agreement, ownership of your eternal soul automatically

passes to us . . . " In some jurisdictions, a contract is either wholly valid or it is invalid. Therefore, this one provision could invalidate the entire license agreement, at least in some secular courts. Mother Jones' Son apparently recognizes that risk, but argues in its advertising, "Given the remotest chance some supernatural entity could actually enforce the 'soulcatcher' clause, you'd be a real bozo to take any chances."

By way of comparison, Section 101 of the 1976 Copyright Act (17 USC Section 106) grants the author of a copyrighted work several exclusive rights, including the right to reproduce or distribute the work, and 17 USC Section 117(2), which was added in 1980 by the Commission on New Technological Uses (CONTU), grants the owner of a lawful copy of a copyrighted computer program the right to make archival back-up copies.

The application of these rights to a multiuser machine, such as the IBM PC/AT, is uncertain. An issue could be raised whether a program running on such a machine with more than one user violates the author's exclusive right to copy or peform the work publicly. This same ambiguity could, however, be argued to exist under the Borland and Mother Jones' Son licenses since they prohibit use by more than one person at the same time. While the AT creates the illusion of simultaneous multiple use, technically the machine is capable of processing only one user's instructions at any given instant. Therefore, the technical argument could be made that the license agreement was not violated.

Neither Borland nor Mother Jones' Son has offered an agreement that would be satisfactory in dealing with an expensive software package and negotiated terms. Of course, it should be borne in mind the type of products that both companies are selling: essentially low-cost utility programs. What is appropriate for programs designed for computer literates may not be appropriate for accounting packages intended to be used by people unfamiliar with how a computer works.

It will be interesting to watch and see if the computer software industry will follow the trend that is being set by Jones and Borland or whether instead it will follow the one being set by stricter copy-protection schemes such as Prolok.

Max Stul Oppenheimer, PC, is a partner in the law firm of Venable, Baetjer & Howard, located in Baltimore, Maryland.

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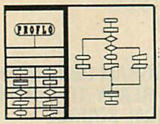

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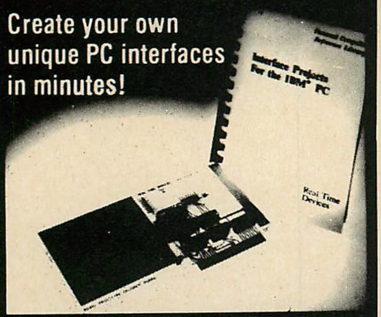

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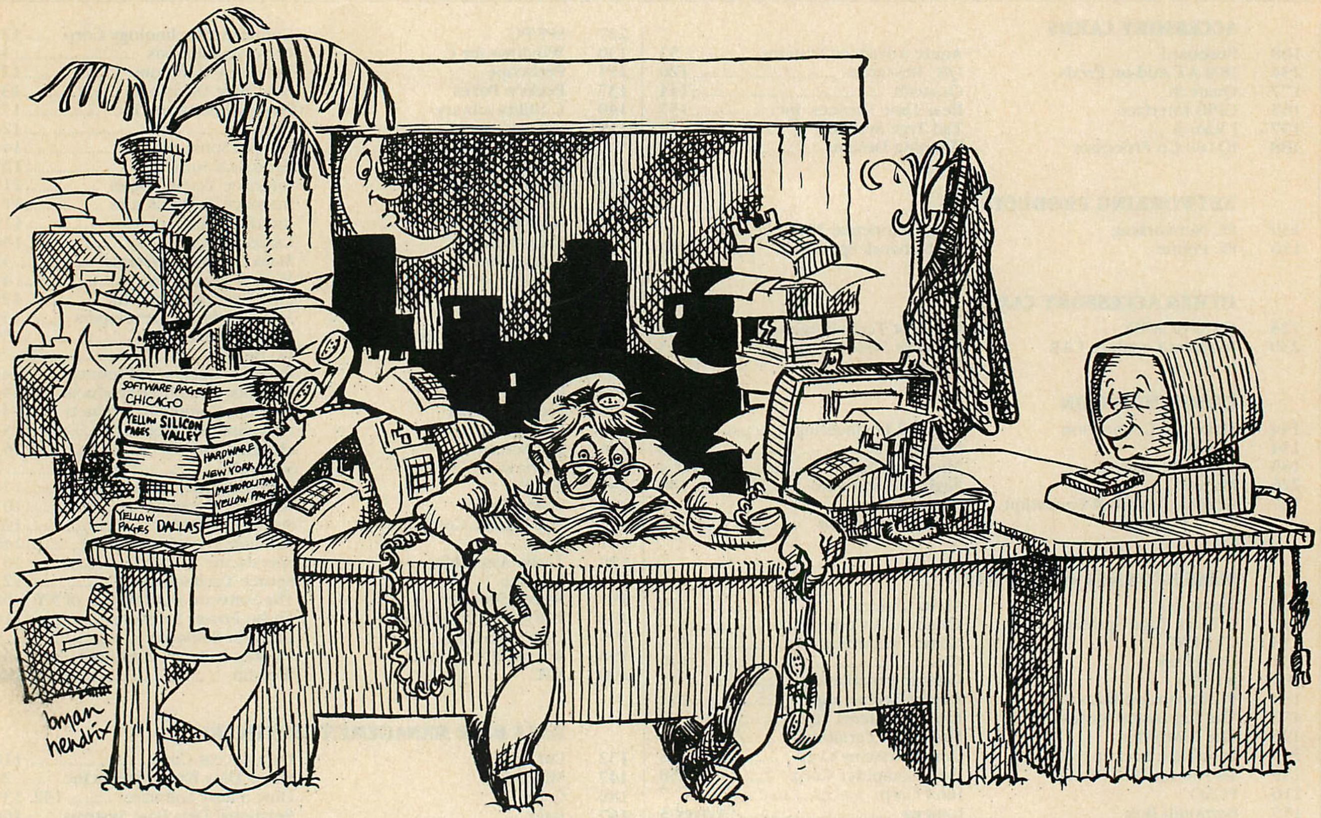

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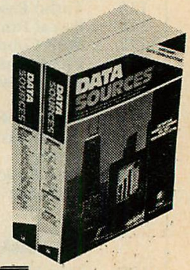

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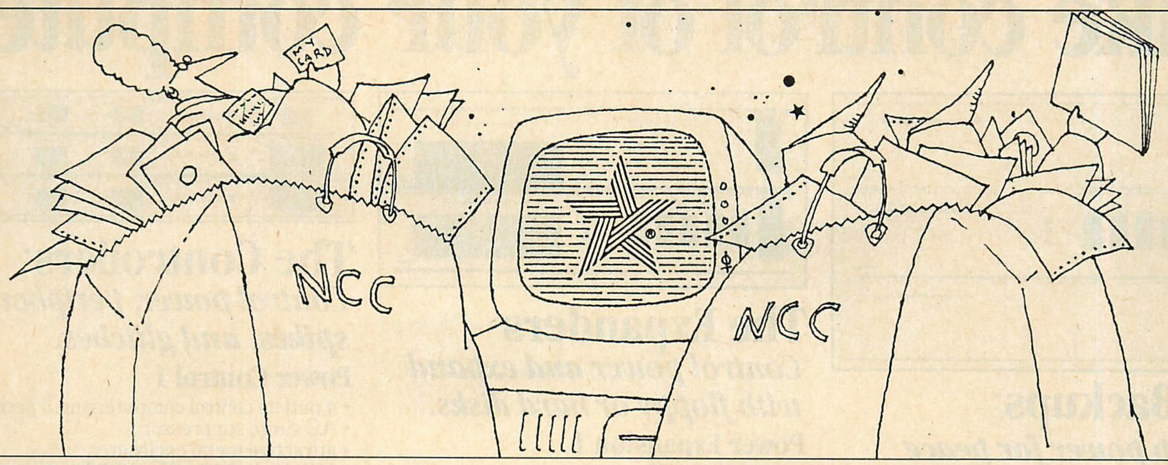

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JULY

July 10-12
Local Area Networks for the IBM World
San Francisco, CA
Sponsor: Communications Solutions, Inc.
Contact: CSI, 992 S. Saratoga-Sunnyvale Road, San Jose, CA 95129; 408/725-1568

July 10-12
World Computer Graphics 85
New York, NY
Contact: WCGA, 2033 M Street, NW, Suite 399, Washington, DC 20036; 202/775-9556 or NCGA, 8401 Arlington Blvd., Suite 601, Fairfax, VA 22031; 703/698-9600

July 15-18
National Computer Conference
Chicago, IL
Sponsor: AFIPS and ACM, IEEE-CS, DPMA, SCS
Contact: Helen Mugnier, AFIPS, 1899 Preston White Drive, Reston, VA 22091; 703/620-8926

July 22-26
SCS 85: Summer Computer Simulation Conference and Exhibits
Chicago, IL
Contact: Charles A. Pratt, SCS, P. O. Box 2228, La Jolla, CA 92038-2228; 619/459-3888

July 22-26
SIGGRAPH 85—The 12th Annual Conference on Computer Graphics and Interactive Techniques
San Francisco, CA
Sponsor: ACM SIGGRAPH with Eurographics, IEEE
Contact: SIGGRAPH 85 Conference, Services Office, 111 E. Wacker Drive, Chicago, IL 60601; 312/664-6610

July 22-26
Second Annual Summer Tutorial and Workshop
Colorado Springs, CO
Sponsor: Rocky Mountain Institute of Software Engineering
Contact: RMISE, P. O. Box 3521, Boulder, CO 80303; 303/499-4782

July 25-28
SOG IV
Bend, OR
Sponsor: Micro Cornucopia
Contact: Dorcas Dsenis, Micro Cornucopia, Inc., P. O. Box 223, Bend, OR 97709; 503/382-8048

AUGUST

August 1-3
The Electronic Library/ Automating Education
Dallas, TX
Contact: Infomart, 1950 Stemmons Freeway, Dallas, TX 75207

August 5-7
4th ACM SIGACT-SIGOPS Symposium on Principles of Distributed Computing
Minaki, Ontario, Canada
Call for papers: Dr. H. R. Strong, IBM Research K55/ 281, 5600 Cottle Road, San Jose, CA 95193

August 20-23
1985 International Conference on Parallel Processing (14th Annual)
St. Charles, IL
Sponsor: The Pennsylvania State University, IEEE, ACM
Call for papers: Dr. Doug DeGroot, M/S 21-133, T. J. Watson Research Center, P. O. Box 218, IBM Corp., Yorktown Heights, NY 10598; 914/945-3497

August 28-30
8th International Conference on Software Engineering
London, England
Sponsor: British Computer Society, IEE, IEEE-CS with ACM SIGSOFT
Contact: Eighth ICSE, c/o IEEE Computer Society, P. O. Box 639, Silver Spring, MD 20901

SEPTEMBER

September 3-6
OASI Third Annual Conference: The Integrated Office—How Soon?
Bloomington, MN
Contact: OASI, 2108 C Gallows Road, Vienna, VA 22180; 703/790-0490

September 5-7
3rd Personal Computer Faire
San Francisco, CA
Contact: David Small, Computer Faire, Inc., 181 Wells Avenue, Newton, MA 02159; 617/965-8350

September 9-11
Federal Computer Conference
Washington, DC
Contact: The Federal Computer Conference, P. O. Box N, Wayland, MA 01778; 617/358-5356

September 10-13
9th Data Communications Symposium
Whistler Mountain, British Columbia, Canada
Sponsor: ACM SIGCOMM, IEEE-CS, IEEE Communications Society
Contact: W. P. Lidinsky, Room 6B 309, AT&T Bell Laboratories, Naperville Wheaton Road, Naperville, IL 60566; 312/979-6817

September 11-13
CAD 2001: The Countdown
London, England
Contact: CAD Seminars, Inc., 150 E. Riverside, Suite 400, Austin, TX 78704; 512/445-7342

September 17-19
Sixth Annual SOFTWARE/expo
Dallas, TX
Contact: SOFTWARE/expo, Suite 205, 2400 E. Devon Avenue, Des Plaines, IL 60018; 312/299-3131

September 18-20
UNIX EXPO
New York, NY
Contact: Robert P. Birkfeld or Don Berey, National Expositions Co., Inc., 14 W. 40th Street, New York, NY 10018; 212/391-9111

September 24-26
AI/Europa: Artificial Intelligence/Fifth Generation Computer Technology
Wiesbaden, West Germany
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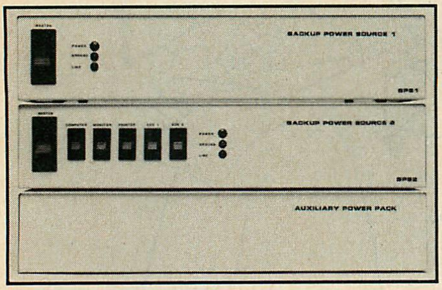

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Backup power for peace of mind and memory.

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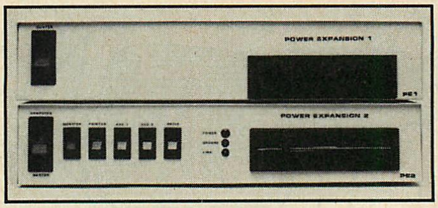

The Expanders™

Control power and expand with floppy or hard disks.

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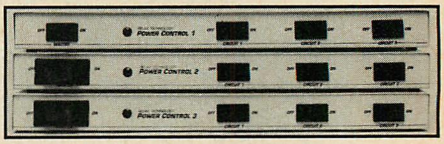

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- 1 stage noise filter
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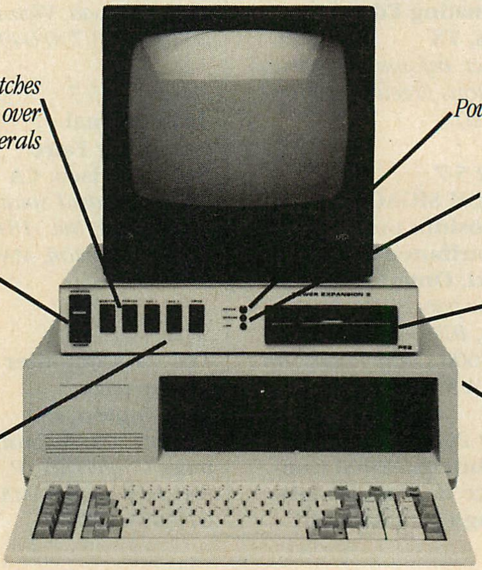

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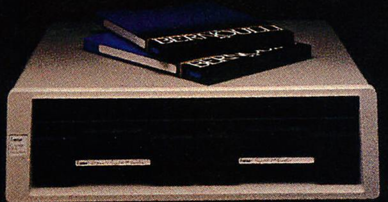
THE NEW STANDARD OF MODERN OFFICE DATA STORAGE.



Free yourself from the limitations of shared and finite hard disk storage. Your dynamic and expanding business data needs demand a more versatile way to deal with critical information.

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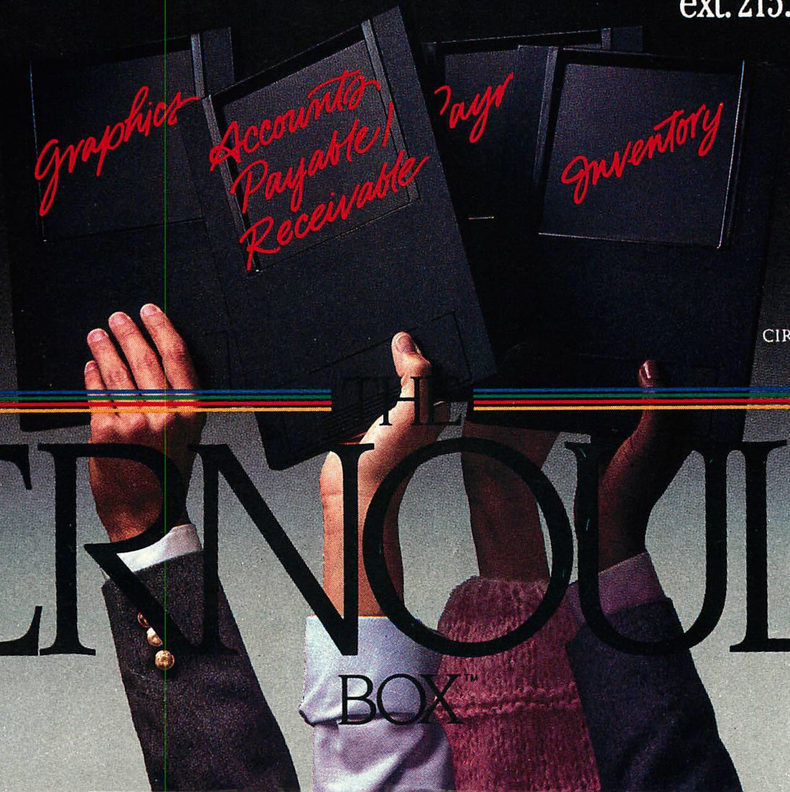
The Bernoulli Box works with the IBM PC, XT, AT, and most compatibles. For your nearest dealer, call 1-800-556-1234 ext. 215. In California, call 1-800-441-2345 ext. 215.



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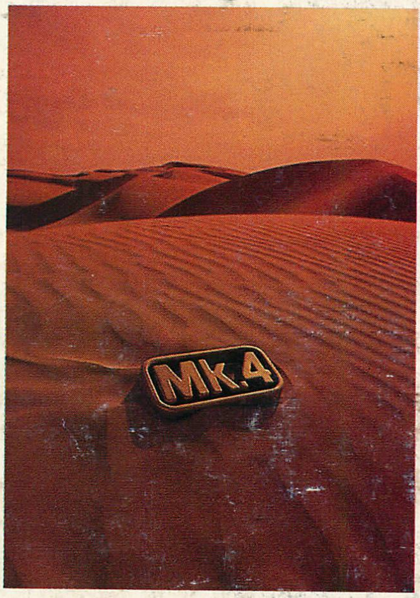
CIRCLE NO. 155 ON READER SERVICE CARD

THE BERNOULLI BOX™

New Generation Communications



Our new Crosstalk Mark 4 behaves just as reliably as the Crosstalk you've always trusted. But when you ask it for a bit extra, you're in for some surprises.

Up To 15 Concurrent Sessions

Mark 4 supports the X.PC multiple-session protocol, so it's capable of up to 15 concurrent communications sessions, each with the end-to-end error-checking needed for tomorrow's higher speed modems.

With more than one session going on at once, you need some way to keep track of them all. Crosstalk Mark 4 has that, too.

What You Get Is What You See

Mark 4 identifies each session with a "page" number. You can flick from one session to another with one keystroke. See each one full screen.

But if you'd like to keep an eye on more than one session at once, you can create windows — as many as you need in any size or shape — to display them all.

Menu? Or Command?

No matter how expert you are, Mark 4 is just your speed. It operates on command, or with a menu, or any combination of the two.

If you need help at any point in your command sequence, Mark 4 gives you suggestions that apply precisely to the task at hand.

Why Repeat Yourself?

If you make the same calls often, as most people do, Mark 4 can save you a lot of dull repetition. It has built-in command programs to call up and log in to most of the major information utilities.

But Mark 4 goes one step further. It can "memorize" any command sequence you perform, then repeat it that way any time you ask it to. You can't make programming much easier than that.

And Now, By Popular Request ...

— Mark 4 has a text-editor built in. You can create and edit files without having to leave Crosstalk.

— Mark 4 emulates the most popular terminals, including IBM 3101, DEC VT-52, VT-100, and the TeleVideo 900 series. Most other programs emulate one or two.

— In addition to X.PC, Crosstalk Mark 4 supports Kermit, Xmodem, and of course our own Crosstalk protocol.

How New Is New Generation Communication?

New enough for the advanced breed of modem that's already coming around the corner. New enough to give you the best high-speed, error-checked communication possible on noisy phone lines — or secure dedicated lines.

Finally, because Crosstalk is already the industry standard for small business computers, Mark 4 is at home in a broader universe than any other communications software.

It may be new and improved and revolutionary — but it's still Crosstalk.

CROSSTALK™ Mk.4

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